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REVIEW

# Interventional Oncology: Should Interventional Radiotherapy (Brachytherapy) be Integrated into Modern Treatment Procedures?

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**OBJECTIVE**

The delivery of a very high dose by radiotherapy to a dedicated target with minimal surrounding normal tissue dose is a challenging situation. From a radiotherapy point of view, in several anatomic situations, the most optimal method is the use of interventional radiotherapy (brachytherapy; IRT) alone or in combination with other established interventional tumor cell eliminating methods.

**METHODS**

First, Interventional Radiotherapy, Interventional Radiology, Interventional Endoscopy and Interventional Chemotherapy have the same aim of eliminating tumor tissue. Second, target definition and some IRT application techniques need multidisciplinary teamwork.

**RESULTS**

Multidisciplinary teams have the best potential to offer the best possible cure in localized solid tumors or in selected oligometastatic disease. Examples for this kind of service are given for H&N-, anal-, vaginal-, breast-, prostate cancers as well as in oligometastatic disease. The combined use of interventional tumor ablation techniques is demonstrated.

**CONCLUSION**

Interventional Oncology has the potential to improve the treatment results in localized solid cancers or in selected oligometastatic disease, and large workload Interventional Oncology Centers could have an important role in the patient service, in the education as well as in the clinical research.

**Keywords:** Brachytherapy; interventional oncology; interventional radiotherapy; multidisciplinarity; personalized medicine; world-class medicine.



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## Introduction

The delivery of a very high dose by radiotherapy to a dedicated target is a challenging situation. The cooperation between different experts, like diagnostic and interventional radiologists, surgeons, endoscopy experts and radiation oncologists improve the accuracy of target definition [1-6] and it offers the possibility to create the best possible implant geometry with or without surgical tumor tissue removal.[7,8]

Interventional radiotherapy (brachytherapy; IRT) represents the optimal method for applying a high radiation dose conformity within the target volume with rapid dose fall-off in adjacent organs at risk, relatively short treatment times and good functional outcomes.[7,9,10]

## Materials and Methods

Interventional Radiotherapy, Interventional Radiology, Interventional Endoscopy and Interventional Chemotherapy have the same aim - the elimination of tumor; accompanied with minimal surrounding normal tissue injury.

The ablation target definition is based on up-to-date imaging methods, as well as the IRT application techniques need multidisciplinary teamwork.

## Results

Multidisciplinary teams have the potential to offer the best possible cure in localized solid tumors as well as in selected oligometastatic disease. Examples for this kind of service are given for H&N-, anal-, vaginal-, breast-, prostate cancers and in oligometastatic disease. The combined use of interventional tumor ablation techniques are demonstrated. Interventional Oncology has the potential to improve the treatment results in localized solid cancers or in selected oligometastatic disease.

## Discussion

Modern oncology offers personalized treatments. The choice of the best possible treatment should be based on multidisciplinary discussion [11] focusing to efficacy, feasibility and costs benefit but also considering the patient's age, clinical condition, presentation of disease and patient's particular needs (travel, work, family). A radiation oncologist usually needs additional experience of other specialty representatives in these decisions as well as in the procedure performance.

In head & neck cancers (H&N) the cooperation of representatives of imaging experts (diagnostic radiology, nuclear medicine), H&N surgery, dento-maxillary- and plastic surgery, neurosurgery and external beam radiotherapy (EBRT) as well as of interventional radiotherapy and medical oncology is mandatory.[8,12-15] In prostate cancer treatments IRT experts need the additional experience of a radiologist to perform staging investigations+mpMRI (for defining the dominant intraprostatic lesions), the urologist, who has as central role in the patient selection (biopsies, IPSS, uroflow, residual urine volume definition, as well as performing the follow-up). If biological planning is applied, experience with mpTRUS (multi-parametric transrectal ultrasound) is necessary in the real-time planning procedure. [4,16-20] Furthermore, in many situations, the medical oncologist can offer invaluable help in systematic treatment decisions. Additionally, we need the cooperation of a pathology and anesthesia expert.[21] In anal and vaginal cancer IRT usually transrectal and/or transvaginal ultrasound implantation guidance is used. The knowledge of a proctologist/gynecologist is necessary for optimal orientation and performance of the implantation technique, as well as the presence of an anesthetist at the implantation procedure is obligatory.[22-24] In breast cancer IRT, independently from the fact of a planned partial breast or boost implantation, multidisciplinary decision-making is obligatory. The cooperation of imaging experts, pathologists, breast surgeons and IRT/EBRT experts offers the best possible treatment results.[25-27]

Nowadays, many minimally invasive procedures are spreading in the oncological management especially for elderly or frail patients.[28,29] There are different kinds of interventions to treat localized malignancies or oligometastatic disease. These can be collected under the name "Interventional Oncology". The four identified main interventional fields (Interventional Radiotherapy, Interventional Radiology, Interventional Endoscopy and Interventional Chemotherapy) focus to the same aim of eliminating tumor tissue with maximal possible normal tissue-; as well as function preservation. Many procedures could be proposed alternatively among them and only a detailed case evaluation and multidisciplinary discussion can result in the offer to the patient regarding the best therapeutic choice. The described procedure determines the need for multidisciplinarity and an "Interventional Oncology Center (IOC)" could offer a possible solution. The IOC is an "interdisciplinary service for diagnosis and

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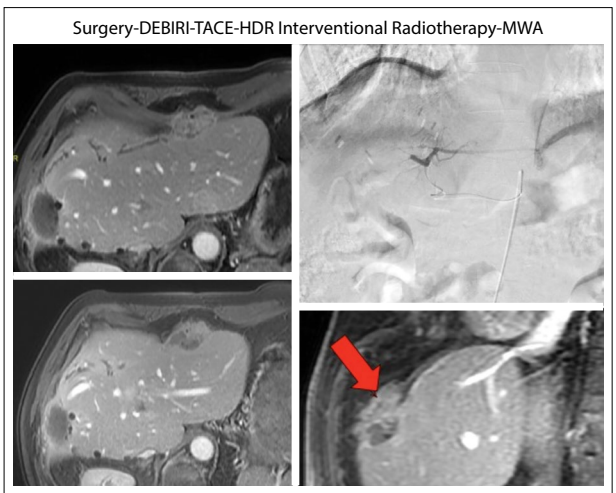
treatment of cancer and cancer-related problems using targeted (focal) minimally invasive procedures" and should have the possibility to evaluate every patient by an IRT expert, an interventional radiologist and an interventional endoscopy specialist.

There are different endovascular focal treatments and percutaneous interventional tumor ablation methods by the team members available: rans-arterial chemo-embolization (TACE), trans-arterial radio-embolization (SIRT), microwave ablation, radiofrequency ablation, and cryotherapy. The specialty of radiotherapy offers IRT or electro-chemotherapy (ECT) for local treatments.[30] In there recent literature all of these interventions were published with good results; however, comparative studies are very rare.[9,31-33] Treatments with favorable outcome were reported in different anatomic sites like head & neck-, bone-, liver-, soft tissue- and peripheral lung tumors or oligometastes.[9,34-40] Recently, the advantage of a robotic implantation with the use of a personalized 3D printed template compared to the manual implantation with personalized 3D printed template guidance was documented.[41] Some groups use seed implants, other the HDR stepping source technology. In HDR practice, dose distribution can be better personalized by adjusting dwell times and dwell distances, which allow conformal radiation delivery. This tool can best used if the implant geometry is optimal and the one doesn´t need to use the optimization tool to compensate for poor catheter geometry and minimize radiation dose to adjacent OARs. Furthermore, without taking in account the different biological dose needs of the targeted tumor (hypoxia, stem cell density, etc.), improved tumor control from dose intensification will always come at the penalty of higher early- and late toxicity rates. A potential way to avoid this is to use techniques to focus the escalated dose to the high-risk regions.[18,20,16] Additionally, in a high workload IRT department HDR brachytherapy treatments are more economical.[42-44] Added value is the advantage of IRT using the possibility of multiple and repeated applications due to the small volume normal tissue irradiation.[45]

Since reports about patient cohorts treated by multidisciplinary IRT are rare, the creation of international large databases and their analysis could help to find high level evidences in the future.[46-48] Moreover, we need educational centers focusing to world-class medicine by multidisciplinary decision-making and multidisciplinary treatment performance.[49] The future belongs to multidisciplinary type of treatments-as documented with the following case: The liver metastases of a colon cancer were cured in the right lobe with the applied TACE (trans-arterial chemo-embolization); however, there was a residual due to the vascular supply from the infiltrated diaphragm. The residual was treated with a single-shoot 20 GyHDR-IRT. In the post-treatment imaging a vital rest of the metastasis was detected and finally treated successfully with MWA (microwave ablation). (Figs. 1-4). Multidisciplinary treatments should be performed on the highest level of performance quality; however, standards are only of value if they are implemented, reviewed, audited and improved and if there is a clear mechanism in place-to monitor and address failure to meet agreed standards.[50] The optimal places to realize it, are dedicated Centers of Excellence.[51] In Centers of Excellence is possible to collect an appropriate number of trained staff, to participate in clinical trials, as well as to introduce a safety culture with reporting and learning systems in place to support learning from incidents and errors of all procedural levels. An additional advantage is if different Centers of Excellence are cooperating in a dedicated network on the national and on the international level. The key issues for moving towards a world-class service requires changes in work culture as well as in work organization: Optimizing of the planning across patient pathways, Regular multidisciplinary tumor board discussions to offer the highest quality of personalized medicine, Strengthening of multi-disciplinary team work in diagnosis, treatment, quality assurance and research, Co-ordination of the referral system, which is disseminated down to home




The lession in the right lobe could be treated by TACE-in the left lobe there was a residual due to the vascular supply from the infiltrated diaphragm (red arrow).

**Fig. 1.** Case presentation, part A.

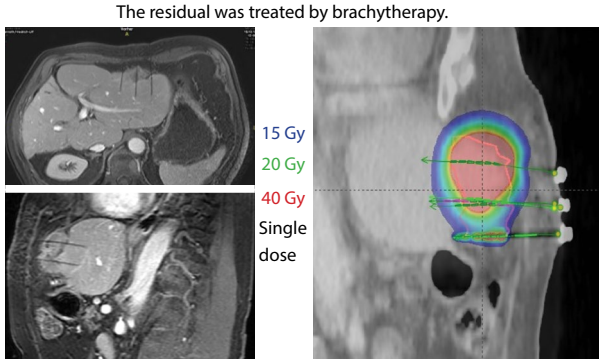



**Fig. 2.** Case presentation, part B.

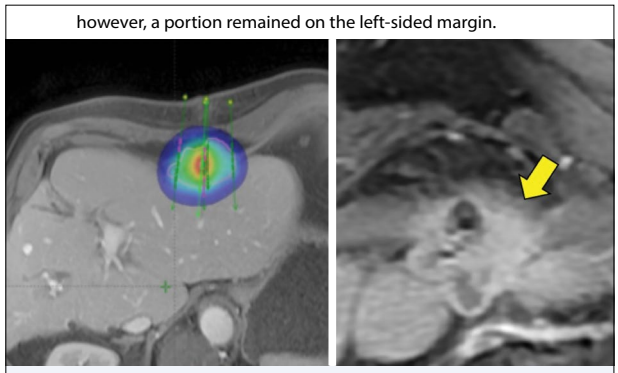



**Fig. 3.** Case presentation, part C.

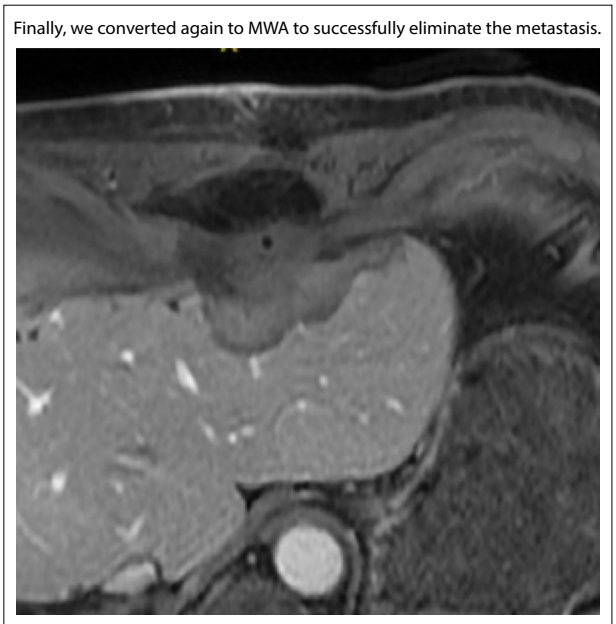



**Fig. 4.** Case presentation, part D.

doctor level, Adequate and continous teaching activities on an up-to-date level by the use of latest informatics technology.

IRT represents approximately 15-25% of the workload of a large radiotherapy department [52], therefore it seems to be an advantage if specialized regional IRT centers would serve a larger region in a network and in close cooperation with the participating radiation therapy departments. On this way, the heavy workload and the variety of anatomic sites allow efficient education and clinical research work on the topic.

## Conclusion

Multidisciplinary Interventional Oncology (MIO) has the potential to improve the treatment results in localized solid cancers or in selected oligometastatic diseases with healthcare economical advantages. An Interventional Oncology Centre with a large workload could play an important role in the patient service, in the education as well as in the clinical research.

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## References

1. Mattiucci GC, Autorino R, Tringali A, Perri V, Balducci M, Deodato F, et al. A Phase I study of high-dose-rate intraluminal brachytherapy as palliative treatment in extrahepatic biliary tract cancer. Brachytherapy 2015;14(3):401–4.
2. Autorino R, Mattiucci GC, Ardito F, Balducci M, Deodato F, Macchia G, et al. Radiochemotherapy with Gemcitabine in Unresectable Extrahepatic Cholangiocarcinoma: Long-term Results of a Phase II Study. Anticancer Res 2016;36(2):737–40.
3. Nestle U, Weber W, Hentschel M, Grosu AL. Biological imaging in radiation therapy: role of positron emission tomography. Phys Med Biol 2009;54(1):R1–25.

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doi: 10.5505/tjo.2019.4

4. Postema A, Mischi M, de la Rosette J, Wijkstra H. Multiparametric ultrasound in the detection of prostate cancer: a systematic review. World J Urol 2015;33(11):1651–9.
5. Tanderup K, Viswanathan AN, Kirisits C, Frank SJ. Magnetic resonance image guided brachytherapy. Semin Radiat Oncol 2014;24(3):181–91.
6. Luo X, Mori K, Peters TM. Advanced Endoscopic Navigation: Surgical Big Data, Methodology, and Applications. Annu Rev Biomed Eng 2018;20:221–51.
7. Morikawa LK, Zelefsky MJ, Cohen GN, Zaider M, Chiu J, Mathur N, et al. Intraoperative high-dose-rate brachytherapy using dose painting technique: evaluation of safety and preliminary clinical outcomes. Brachytherapy 2013;12(1):1–7.
8. Martínez-Monge R, Alcalde J, Concejo C, Cambeiro M, Garrán C. Perioperative high-dose-rate brachytherapy (PHDRB) in previously irradiated head and neck cancer: Initial results of a Phase I/II reirradiation study. Brachytherapy 2006;5(1):32–40.
9. Bretschneider T, Ricke J, Gebauer B, Streitparth F. Image-guided high-dose-rate brachytherapy of malignancies in various inner organs - technique, indications, and perspectives. J Contemp Brachytherapy 2016;8(3):251–61.
10. Martínez-Monge R, Valtueña Peydró G, Cambeiro M, Aramendía JM, Gimeno M, Santisteban M, et al. Perioperative high-dose-rate brachytherapy in locally advanced and recurrentgynecological cancer: Final results of a Phase II trial. Brachytherapy 2018;17(5):734–41.
11. El Saghir NS, Charara RN, Kreidieh FY, Eaton V, Litvin K, Farhat RA, et al. Global Practice and Efficiency of Multidisciplinary Tumor Boards: Results of an American Society of Clinical Oncology International Survey. J Glob Oncol 2015;1(2):57–64.
12. Teudt IU, Kovàcs G, Ritter M, Melchert C, Soror T, Wollenberg B, et al. Intensity modulated perioperative HDR brachytherapy for recurrent and/or advanced head and neck metastases. Eur Arch Otorhinolaryngol 2016;273(9):2707–15.
13. Tagliaferri L, Bussu F, Rigante M, Gambacorta MA, Autorino R, Mattiucci GC, et al. Endoscopy-guided brachytherapy for sinonasal and nasopharyngeal recurrences. Brachytherapy 2015;14(3):419–25.
14. Bussu F, Tagliaferri L, Mattiucci G, Parrilla C, Dinapoli N, Miccichè F, et al. Comparison of interstitial brachytherapy and surgery as primary treatments for nasal vestibule carcinomas. Laryngoscope 2016;126(2):367–71.
15. Strege RJ, Kovács G, Maune S, Holland D, Niehoff P, Eichmann T, et al. Feasibility of combined operation and perioperative intensity-modulated brachytherapy of advanced/recurrent malignancies involving the skull base. Strahlenther Onkol 2005;181(2):97–107.
16. Alonzi R. Functional Radiotherapy Targeting using Focused Dose Escalation. Clin Oncol (R Coll Radiol) 2015;27(10):601–17.
17. Dattoli MJ, Sorace RA, Bravo SM, Bostwikc D. Prostate biopsies using both gray scale and 3D color flow power Doppler ultrasound (3DCFPDU). ASCO 2015 Genitourinary Cancer Symposium February 26-28, 2015. Available at: http://www.dattoli.com/wp-content/uploads/2015/03/newposter.pdf. Accessed Jan 24, 2019.
18. Kovács G, Melchert C, Sommerauer M, Walden O. Intensity modulated high-dose-rate brachytherapy boost complementary to external beam radiation for intermediate- and high-risk localized prostate cancer patients--how we do it in Lübeck/Germany. Brachytherapy 2007;6(2):142–8.
19. Ellis RJ, Zhou H, Kim EY, Fu P, Kaminsky DA, Sodee B, et al. Biochemical disease-free survival rates following definitive low-dose-rate prostate brachytherapy with dose escalation to biologic target volumes identified with SPECT/CT capromab pendetide. Brachytherapy 2007;6(1):16–25.
20. Kovács G, Müller K, Soror T, Melchert C, Guo X, Jocham D, et al. Results of multiparametric transrectal ultrasound-based focal high-dose-rate dose escalation combined with supplementary external beam irradiation in intermediate- and high-risk localized prostate cancer patients. Brachytherapy 2017;16(2):277–81.
21. Williams SB, Kamat AM. The Multidisciplinary Approach to Prostate Cancer Management: From Diagnosis and Beyond. Everyday Urology – Oncology Insights 2017;2(2):11–3.
22. Doniec JM, Schniewind B, Kovács G, Kahlke V, Loehnert M, Kremer B. Multimodal therapy of anal cancer added by new endosonographic-guided brachytherapy. Surg Endosc 2006;20(4):673–8.
23. Tagliaferri L, Manfrida S, Barbaro B, Colangione MM, Masiello V, Mattiucci GC, et al. MITHRA - multiparametric MR/CT image adapted brachytherapy (MR/CT-IABT) in anal canal cancer: a feasibility study. J Contemp Brachytherapy 2015;7(5):336–45.
24. Glaser SM, Beriwal S. Brachytherapy for malignancies of the vagina in the 3D era. J Contemp Brachytherapy 2015;7(4):312–8.
25. Strnad V, Hannoun-Levi JM, Guinot JL, Lössl K, Kauer-Dorner D, Resch A, et al; Working Group Breast Cancer of GEC-ESTRO. Recommendations from GEC ESTRO Breast Cancer Working Group (I): Target definition and target delineation for accelerated or boost Partial Breast Irradiation using multicatheter interstitial brachytherapy after breast conserving closed cavity surgery. Radiother Oncol 2015;115(3):342–8.
26. Major T, Gutiérrez C, Guix B, van Limbergen E, Strnad V, Polgár C; Breast Cancer Working Group of GEC-ESTRO. Recommendations from GEC ESTRO Breast

Cancer Working Group (II): Target definition and target delineation for accelerated or boost partial breast irradiation using multicatheter interstitial brachytherapy after breast conserving open cavity surgery. Radiother Oncol 2016;118(1):199–204.
27. Roth AM, Kauer-Dorner D, Resch A, Schmid A, Thill M, Niehoff P, et al; Groupe Europeen de Curietherapie-European Society for Therapeutic Radiology and Oncology (GEC-ESTRO) Breast Working Group. Is oncoplastic surgery a contraindication for accelerated partial breast radiation using the interstitial multicatheter brachytherapy method? Brachytherapy 2014;13(4):394–9.
28. Yanazume Y, Yanazume S, Iio K, Yonekura R, Kojima N, Uchida N, et al. Major causes of impractical brachytherapy in elderly patients with uterine cervical cancer. J Obstet Gynaecol Res 2014;40(6):1725–32.
29. Lancellotta V, Kovács G, Tagliaferri L, Perucci E, Colloca G, Valentini V, et al. Age Is Not a Limiting Factor in Interventional Radiotherapy (Brachytherapy) for Patients with Localized Cancer. BioMed Research International 201; ID 2178469, 10pages.
30. Kovács G, Tagliaferri L, Valentini V. Is an Interventional Oncology Center an advantage in the service of cancer patients or in the education? The Gemelli Hospital and INTERACTS experience. J Contemp Brachytherapy 2017;9(6):497–8.
31. Gillams A, Goldberg N, Ahmed M, Bale R, Breen D, Callstrom M, et al. Thermal ablation of colorectal liver metastases: a position paper by an international panel of ablation experts, The Interventional Oncology Sans Frontières meeting 2013. Eur Radiol 2015;25(12):3438–54.
32. Imai N, Ishigami M, Ishizu Y, Kuzuya T, Honda T, Hayashi K, et al. Transarterial chemoembolization for hepatocellular carcinoma: A review of techniques. World J Hepatol 2014;6(12):844–50.
33. Goldberg SN, Gazelle GS, Mueller PR. Thermal ablation therapy for focal malignancy: a unified approach to underlying principles, techniques, and diagnostic imaging guidance. AJR Am J Roentgenol 2000;174(2):323–31.
34. Li J, Zhang L, Xu W, Wang T, Zhou L, Xie Q, et al. Computed tomography-guided implantation of 125I seeds brachytherapy for recurrent multiple pulmonary oligometastases: initial experience and results. J Contemp Brachytherapy 2017;9(2):132–8.
35. Lu M, Yao W, Zhang T, Fan W, Zhong Z, Li J, et al. Feasibility and Efficacy of Microwave Ablation Combined with Iodine-125 Seed Implantation in Local Control of Recurrent Retroperitoneal Liposarcomas: Initial Clinical Experience. Oncologist 2017;22(12):1500–5.
36. Han T, Yang X, Xu Y, Zheng Z, Yan Y, Wang N. Therapeutic value of 3-D printing template-assisted 125I-seed implantation in the treatment of malignant liver tumors. Onco Targets Ther 2017;10:3277–83.
37. Jiao D, Wu G, Ren J, Han X. Radiofrequency ablation versus 125I-seed brachytherapy for painful metastases involving the bone. Oncotarget 2016;7(52):87523–31.
38. Martínez-Monge R, Pérez-Ochoa A, San Julián M, Aquerreta D, Sierrasesúmaga L. Bone HDR brachytherapy in a patient with recurrent Ewing's sarcoma of the acetabulum: alternative to aggressive surgery. Brachytherapy 2003;2(2):114–6.
39. Jiang YL, Meng N, Wang JJ, Jiang P, Yuan HSh, Liu C, et al. CT-guided iodine-125 seed permanent implantation for recurrent head and neck cancers. Radiat Oncol 2010;5:68.
40. Kolotas C, Baltas D, Zamboglou N. CT-Based interstitial HDR brachytherapy. Strahlenther Onkol 1999;175(9):419–27.
41. Ma X, Yang PZ, Jiang PS, Huo PB, Cao Q, Chai PS, et al. Effectiveness and safety of a robot-assisted 3D personalized template in 125I seed brachytherapy of thoracoabdominal tumors. J Contemp Brachytherapy 2018;10(4):368–79.
42. Shah C, Lanni TB Jr, Ghilezan MI, Gustafson GS, Marvin KS, Ye H, et al. Brachytherapy provides comparable outcomes and improved cost-effectiveness in the treatment of low/intermediate prostate cancer. Brachytherapy 2012;11(6):441–5.
43. Kim H, Rajagopalan MS, Beriwal S, Smith K. Cost-Effectiveness Analysis of 3D Image-Guided Brachytherapy Compared to 2D Brachytherapy in the Treatment of Locally Advanced Cervical Cancer. Int J Radiat Oncol Biol Phys 2014;90(Suppl 1):S587.
44. Sher DJ, Wittenberg E, Suh WW, Taghian AG, Punglia RS. Partial-breast irradiation versus whole-breast irradiation for early-stage breast cancer: a cost-effectiveness analysis. Int J Radiat Oncol Biol Phys 2009;74(2):440–6.
45. Rühl R, Lüdemann L, Czarnecka A, Streitparth F, Seidensticker M, Mohnike K, et al. Radiobiological restrictions and tolerance doses of repeated single-fraction hdr-irradiation of intersecting small liver volumes for recurrent hepatic metastases. Radiat Oncol 2010;5:44.
46. Tagliaferri L, Kovács G, Autorino R, Budrukkar A, Guinot JL, Hildebrand G, et al. ENT COBRA (Consortium for Brachytherapy Data Analysis): interdisciplinary standardized data collection system for head and neck patients treated with interventional radiotherapy (brachytherapy). J Contemp Brachytherapy 2016;8(4):336–43.
47. Tagliaferri L, Pagliara MM, Boldrini L, Caputo CG, Azario L, Campitelli M, et al. INTERACTS

Turk J Oncol 2019;34(Supp 1):16–22
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(INTErventional Radiotherapy ACtive Teaching School) guidelines for quality assurance in choroidal melanoma interventional radiotherapy (brachytherapy) procedures. J Contemp Brachytherapy 2017;9(3):287–95.

48. Tagliaferri L, Budrukkar A, Lenkowicz J, Cambeiro M, Bussu F, Guinot JL, et al. ENT COBRA ONTOLOGY: the covariates classification system proposed by the Head & Neck and Skin GEC-ESTRO Working Group for interdisciplinary standardized data collection in head and neck patient cohorts treated with interventional radiotherapy (brachytherapy). J Contemp Brachytherapy 2018;10(3):260–6.
49. Cullen J, Drabble D, Castellanos C, Brisset L. Recommendations for achieving a world-class radiotherapy service in the UK. Available at: http://www.tavinstitute.org/wp-content/uploads/2014/05/Tavistock_Projects_Recommendations-for-achieving-a-world-class-radiotherapy-service-in-the-UK-.pdf. Accessed Feb 15, 2019.
50. Bogusz-Czerniewicz M, Kaźmierczak D. Organizational, technical, physical and clinical quality standards for radiotherapy. Rep Pract Oncol Radiother 2012;17(4):190–9.
51. Elrod JK, Fortenberry JL Jr. Centers of excellence in healthcare institutions: what they are and how to assemble them. BMC Health Serv Res 2017;17(Suppl 1):425.
52. Guedea F, Venselaar J, Hoskin P, Hellebust TP, Peiffert D, Londres B, et al. Patterns of care for brachytherapy in Europe: updated results. Radiother Oncol 2010;97(3):514–20.