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COVID-19

## Proposed brachytherapy recommendations (practical implementation, indications, and dose fractionation) during COVID-19 pandemic

The ongoing COVID-19 pandemic has impacted the availability of health care resources (personnel and material) for all patients (1–4). This has especially impacted patients with cancer who are at a higher risk of contracting and suffering serious complications from COVID-19 infection (5–9). Nationwide, there have also been limitations placed on procedures including biopsies and cancer surgeries (10). Given the unclear duration for the resource limitations might last, it is imperative to promote clinical efficiencies while maintaining optimal efficacy and safety.

Brachytherapy is an integral part of radiotherapeutic management for a variety of clinical indications. Many brachytherapy procedures are carried out with anesthesia support and with utilization of operating room resources. As such, there is considerable pressure on providers to judiciously select patients in need of brachytherapy. After applicator/catheter placement, there is also substantial variability in planning (CT vs. MRI simulation), isotope selection for low-dose-rate brachytherapy, and dose and fractionation for high-dose-rate brachytherapy. To maximize resources, there is an urgent need to propose efficient dose/fractionation recommendations that are supported by evidence-based medicine. Guidance is additionally needed regarding brachytherapy utilization in patients who develop influenza-like illness, persons under investigation, or those who test positive for COVID-19 (COVID-19 +).

A number of guidelines are now published providing external beam radiation recommendations, but none have focused specifically on brachytherapy (11–13). We fully appreciate that access to brachytherapy is contingent on the impact of COVID-19+ patients on each specific hospital system and that clinical judgment needs to be used when

considering the appropriateness of a treatment plan. Because of the critical role of brachytherapy in the management of a variety of cancers, it is important for institutions to consider offering brachytherapy if appropriate staff and personal protective equipment are available for the protection of patients and staff. Institutions are encouraged to follow guidelines set by their local policy with regard to personal protective equipment use during different surgical procedures.

Through data shown in the table as follows, we suggest practical implementation considerations when using brachytherapy for a variety of clinical indications (Table 1). We also summarize available data supporting the use of higher dose-per-fraction high-dose-rate regimens to allow treatment completion in a shorter course thereby limiting resource utilization and exposure risk. It is strongly recommended that for all modified fractionations being considered, strict respect for normal tissue dosimetric constraints be met using available published data.

We also recognize that our understanding of COVID-19 infections is rapidly evolving and that suggestions regarding appropriate time to wait for re-initiating therapy after a patient recovers from COVID-19 could change and may be institution specific. These suggestions are not meant to replace appropriate clinical judgment.

### Disclosures

Conflicts of Interest: None of the authors have any conflicts of interest to disclose.

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Table 1  
Proposed brachytherapy recommendations (practical implementation, indications, and dose fractionation) during COVID-19 pandemic

Disease site	Indication	Practical implementation considerations during pandemic	Common dose/fractionation	Suggested dose/fractionation during pandemic	References
Gynecological cancers	Intact cervix— Definitive	<ol style="list-style-type: none"> <li>Effort should be made to complete treatment within 7–8 weeks for non-COVID-19 +/-PUI/ILI patients (14).</li> <li>Consider using MRI for first fraction only instead of all fractions especially if 1st MRI shows a minimal residual disease (15).</li> <li>When using brachytherapy consider spinal/epidural anesthesia, oral analgesia or intravenous conscious sedation over general endo-tracheal anesthesia.</li> <li>If patient is COVID-19 +/-PUI/ILI then:                             <ol style="list-style-type: none"> <li>If resources available continue brachytherapy boost with PPE precautions, or</li> <li>Delay till 10–14 days post-recovery from infection and try to increase dose of brachytherapy by 5 Gy cumulative dose for each week delay provided OAR constraints can be met (14).</li> </ol> </li> </ol>	HDR intracavitary ± hybrid interstitial boost after 45–50.4 Gy: 5–6 Gy × 5 fractions, or 7 Gy × 4 fractions (16)	HDR intracavitary ± hybrid interstitial boost after 45 Gy: 7 Gy × 4 fractions (16), or 8 Gy × 3 fractions (16,17) 9 Gy × 2 fractions showed inferior outcomes to 7 Gy × 4 and is not preferred (18)	<ol style="list-style-type: none"> <li>retroEMBRACE, Tanderup <i>et al.</i> PMID: 27350396 (14)</li> <li>University of Pittsburgh, Beriwal <i>et al.</i> PMID 21908180 (15)</li> <li>ABS consensus guidelines, Viswanathan <i>et al.</i> PMID: 22265437 (16)</li> <li>Compendium of fractionation choices for gynecologic HDR brachy. Albuquerque K <i>et al.</i> 2019. PIMD 30979631 (17)</li> <li>Multi-institutional trial, Hendry J <i>et al.</i> ASTRO Annual Meeting 2017 (18).</li> </ol>
	Inoperable endometrial— Definitive	<ol style="list-style-type: none"> <li>Consider using MRI for first fraction only instead of all fractions especially in good responders.</li> <li>When using brachytherapy consider spinal/epidural anesthesia, oral analgesia or intravenous conscious sedation over general endo-tracheal anesthesia.</li> <li>If patient is COVID-19 +/-PUI/ILI then:                             <ol style="list-style-type: none"> <li>Consider hormonal therapy alone (19) and wait 10–14 days after recovery from infection before initiating brachytherapy, or</li> <li>In symptomatic cases may consider EBRT alone (20).</li> </ol> </li> </ol>	HDR intracavitary monotherapy (Stage I): 7–7.5 Gy × 5 fractions (21) HDR intracavitary boost after 45 Gy: 8.5 Gy × 2 fractions, or 6.3–6.5 Gy × 3 fractions, or 5.2 Gy × 4 fractions (22) HDR intracavitary boost after 50.4 Gy: 6 Gy × 2 fractions, or 3.75 Gy × 6 fractions (22)	HDR intracavitary monotherapy (Stage I): 8.5 Gy × 4 fractions (17), or 8–10 Gy × 3 fractions (23) HDR intracavitary boost after 45 Gy: 8.5 Gy × 2 fractions, or 6.3–6.5 Gy × 3 fractions (22) HDR intracavitary boost after 50.4 Gy: 6 Gy × 2 fractions(22)	<ol style="list-style-type: none"> <li>University of Virginia, Staples <i>et al.</i> PMID: 29977988 (19)</li> <li>SEER analysis. Yoo <i>et al.</i> PMID: 26083557 (20)</li> <li>University of Pittsburgh, Gebhardt <i>et al.</i> PMID: 28923412 (21)</li> <li>ABS consensus guidelines, Schwarz <i>et al.</i> PMID: 26186975 (22)</li> <li>Compendium of fractionation choices for gynecologic HDR brachy. Albuquerque K <i>et al.</i> 2019. PIMD 30979631 (17)</li> <li>McGill University, Canada Niazi <i>et al.</i> PMID: 16099598 (23)</li> </ol>

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Table 1 (continued)

Disease site	Indication	Practical implementation considerations during pandemic	Common dose/fractionation	Suggested dose/fractionation during pandemic	References
	Interstitial (template)— Definitive	<ol style="list-style-type: none"> <li>If patient COVID-19 +/PUI/ILI during EBRT then:               <ol style="list-style-type: none"> <li>Delay till 10–14 days after recovery from infection. For patients with cervical cancer consider increasing dose of brachytherapy by 5 Gy cumulative dose for each week delay provided OAR constraints can be met (14). Similar data not available for vaginal or recurrent endometrial cancer. Practitioners can individualize decision in each case.</li> </ol> </li> </ol>	<p>HDR boost after 45–50.4 Gy: 4–6 Gy × 5 fractions (16,24)</p> <p>No consensus recommendation for re-irradiation.</p>	<p>HDR boost after 45 Gy: 7–8 Gy × 3 fractions (24,25)</p> <p>6 Gy × 4 fraction, twice daily (26)</p>	<ol style="list-style-type: none"> <li>retroEMBRACE, Tanderup <i>et al.</i> PMID: 27350396 (14)</li> <li>ABS Consensus Guidelines, Beriwal <i>et al.</i> PMID: 22265440 (24)</li> <li>ABS consensus guidelines, Viswanathan <i>et al.</i> PMID: 22265437 (16)</li> <li>Canadian experience, Taggar <i>et al.</i>, PMID: 27914911 (25)</li> <li>London Health Sciences Center, Canada, D’Souza <i>et al.</i> PMID: 24613570 (26)</li> </ol>
	Postoperative vaginal cuff	<ol style="list-style-type: none"> <li>Can avoid brachytherapy boost after EBRT if no adverse factor like positive/close margin, cervical involvement/LVSI, possibly using 50.4 Gy instead.</li> <li>Avoid placement of gold seeds. Instead consider CT for confirming placement.</li> <li>If patient is COVID-19 +/PUI/ILI,               <ol style="list-style-type: none"> <li>For patients receiving systemic therapy delay brachytherapy until pandemic resolves/resources become available, or</li> <li>For brachytherapy alone patients, could delay treatment to 8 to 9 weeks from date of surgery (27,28), or</li> <li>For brachytherapy boost patients, could delay treatment by 2–3 weeks after EBRT, or</li> <li>If status changes after 1 or 2 fractions, then delay till 10–14 days after recovery from infection.</li> </ol> </li> </ol>	<p>HDR cylinder monotherapy: 7 Gy × 3 fractions to 5 mm, or 5–5.5 Gy × 4–5 Fractions to surface, or 6–7.5 Gy × 5 fractions to surface, or 4 Gy × 6 fractions to surface (17,29)</p> <p>HDR cylinder boost after 45–50.4 Gy: 5–6 Gy × 2–3 fractions to surface, or 4–5.5 Gy × 3 fractions to 5 mm (17,29)</p>	<p>HDR cylinder monotherapy: 3 cm cylinder: 7 Gy × 3 fractions to 5 mm (PORTEC-2) (30)</p> <p>2.5 cm cylinder: 7 Gy × 3 fractions to surface (30,31)</p> <p>HDR cylinder boost after 45 Gy (adverse factors): 5 Gy × 2 fractions at 5 mm (32,33)</p> <p>5 Gy × 1 fraction to surface (34), or</p> <p>HDR Cylinder Boost after 50/50.4 Gy (adverse factors): 6 Gy × 2 fractions to surface (29)</p> <p>Add more fractions if positive margin</p>	<ol style="list-style-type: none"> <li>Henry Ford Hospital, Michigan, Cattaneo <i>et al.</i> PMID: 24444758 (27)</li> <li>University of Pisa, Fabrini <i>et al.</i> PMID: 22213303 (28)</li> <li>ABS consensus guidelines, Small <i>et al.</i>, PMID: 22265439 (29)</li> <li>Compendium of fractionation choices for gynecologic HDR brachy. Albuquerque K <i>et al.</i> 2019. PIMD 30979631 (17)</li> <li>PORTEC-2, Nout <i>et al.</i> PMID: 20206777 (30)</li> <li>Dana-Farber Cancer Institute/Brigham and Women’s Hospital, Alban <i>et al.</i> ABS Annual Meeting 2019 (31).</li> <li>University of Pittsburgh, He <i>et al.</i> PMID: 2752789732</li> <li>PORTEC-3, de Boer <i>et al.</i> PMID: 31345626 (33)</li> <li>BC Canada, Bachand <i>et al.</i> ABS Annual Meeting 2013 (34)</li> </ol>

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Table 1 (continued)

Disease site	Indication	Practical implementation considerations during pandemic	Common dose/fractionation	Suggested dose/fractionation during pandemic	References
Prostate cancer	Monotherapy, boost or salvage	<ol style="list-style-type: none"> <li>1. All monotherapy should be deferred until pandemic resolves/resources become available.</li> <li>2. Defer initiating EBRT and continue hormone therapy for unfavorable and high-risk prostate.</li> <li>3. If already on EBRT, then consider brachytherapy boost. If resources available with PPE precautions, else consider EBRT boost.</li> <li>4. For salvage cases delay brachytherapy and consider hormone therapy until pandemic resolves/resources become available.</li> <li>5. When using brachytherapy consider spinal/epidural anesthesia, or intravenous conscious sedation over general endotracheal anesthesia.</li> <li>6. For patients considered for HDR boost, may start with EBRT first.</li> <li>7. If patient is COVID-19 +/-PUI/ILI during EBRT, then: <ol style="list-style-type: none"> <li>a. Consider interrupting treatment to allow 10–14 days after recovery from infection before re-initiating EBRT/plan for brachytherapy.</li> </ol> </li> <li>8. If patient is COVID-19 +/-PUI/ILI, after 1st fraction HDR, then: <ol style="list-style-type: none"> <li>a. Consider delaying 2nd fraction to allow 10–14 days after recovery from infection.</li> </ol> </li> </ol>	<p>Interstitial monotherapy: HDR 13.5 Gy × 2 (19 Gy × 1 is not appropriate) (35)</p> <p>LDR dose per isotope used. HDR interstitial boost: 45 Gy in 25 fraction pelvic RT or 37.5 Gy in 15 fraction (prostate/seminal vesicles) with HDR boost 15 Gy in one fraction (36,37)</p> <p>Salvage HDR brachytherapy: 8 Gy × 4 fractions, single implant, twice daily (38), or 6 Gy × 6 fractions, two separate implants performed 1 week apart (39)</p>	<p>Interstitial monotherapy: No change in fractionation needed.</p> <p>Interstitial boost after EBRT: No change in fractionation needed.</p>	<ol style="list-style-type: none"> <li>1. Sunnybrook Odette Cancer Center, Toronto, Morton G <i>et al.</i> Green Journal. 2020. PIMD 32146259 (35)</li> <li>2. Sunnybrook Odette Cancer Center, Toronto, Martell K <i>et al.</i> Green Journal. PIMD 31522882 (36)</li> <li>3. Sunnybrook Odette Cancer Center, Toronto, Shahid N <i>et al.</i> Clin Oncol. 2017. PIMD 28190638 (37)</li> <li>4. Memorial Sloan Kettering Cancer Center, Yamada <i>et al.</i> PMID: 24373762 (38)</li> <li>5. University of California-San Francisco, Chen <i>et al.</i> reference PMID: 23474112 (39)</li> </ol>

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Table 1 (continued)

Disease site	Indication	Practical implementation considerations during pandemic	Common dose/fractionation	Suggested dose/fractionation during pandemic	References
Breast cancer	Adjuvant	<ol style="list-style-type: none"> <li>1. Delay adjuvant EBRT or interstitial brachytherapy for low risk breast cancer pts as no detrimental effect in outcome up until 16–20 weeks for ER + invasive breast cancer (40,41) or 12 weeks for DCIS (42)</li> <li>2. Balloon/Catheter-based intracavitary brachytherapy is dependent on presence of cavity and hence, needs to be done sooner</li> </ol>	<p>Balloon/catheter-based HDR: 3.4 Gy × 10 fractions, single implant, twice daily over 5 days (43)</p> <p>IORT: single fraction</p>	<p>Balloon/catheter-based HDR: 7–7.5 Gy × 3 fractions, single implant, twice daily over 1.5 days (44,45) or 7 Gy × 4 fractions, single implant, twice daily over 2 days (46)</p> <p>IORT: No change in fractionation needed</p>	<ol style="list-style-type: none"> <li>1. Sahlgrenska University Hospital, Gothenburg, Sweden, Karlsson <i>et al.</i> PMID: 20729007 (40)</li> <li>2. British Columbia, Canada, Olivotto <i>et al.</i> PMID: 19018080 (41)</li> <li>3. Memorial Sloan Kettering Cancer Center, Shurell <i>et al.</i> PMID: 28960259 (42)</li> <li>4. ABS recommendations, Shah <i>et al.</i> PMID: 29074088 (43)</li> <li>5. Mayo Clinic Rochester, Jethwa <i>et al.</i> PMID 30583041 (44)</li> <li>6. Triumph-T trial, Khan <i>et al.</i> PMID:30611839 (45)</li> <li>7. Phase 1/2 trial, Wilkinson <i>et al.</i> PMID 28787281 (46)</li> </ol>
Skin cancer	Definitive	Delay brachytherapy until pandemic resolves/resources become available.	<p>Surface applicators (dose to 3–5 mm below surface) (47–49):</p> <p>Sensitive area (over very thin skin or with underlying cartilage/bone or cosmetically important areas)</p> <p>3 Gy × 17–18 fractions, or 40–50 Gy in 8–10 fractions</p> <p>Nonsensitive area</p> <p>7 Gy × 6 fractions, or 6 Gy × 7 fractions, or 5 Gy × 8 fractions, or 10 Gy × 3 fractions</p> <p>Molds/flaps (dose to 3–5 mm below surface) (47–49):</p> <p>Sensitive area</p> <p>3 Gy × 17–18 fractions, or 4 Gy × 10 fractions</p> <p>Nonsensitive area</p> <p>40–50 Gy in 10–12 fractions, or 7 Gy × 6 fractions, or 6 Gy × 7 fractions, or 5 Gy × 8 fractions</p> <p>Interstitial (47–49):</p> <p>36–55 Gy in 8–10 fractions</p>		<ol style="list-style-type: none"> <li>1. Spanish brachytherapy group recommendations, Rodriquez <i>et al.</i> PMID: 28808925 (47)</li> <li>2. GEC-ESTRO ACROP Recommendations, Guinot <i>et al.</i> PMID: 29455924 (48)</li> <li>3. ABS working group report, Ouhib <i>et al.</i> PMID: 26319367 (49)</li> <li>4. ABS Consensus Statement, Shah <i>et al.</i> Brachytherapy. Accepted for publication</li> </ol>

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Table 1 (continued)

Disease site	Indication	Practical implementation considerations during pandemic	Common dose/fractionation	Suggested dose/fractionation during pandemic	References
Esophageal cancer	Palliative	Avoid brachytherapy until pandemic resolves/resources become available due to increased risk of staff exposure from droplets. Consider short-course EBRT	Intraluminal HDR monotherapy: 12 Gy × 1 fraction, prescribed to 5–10 mm from source axis (50,51), or 7–7.5 Gy at 10 mm from source axis × 3 fractions (50) Intraluminal HDR with EBRT: 8 Gy at 10 mm × 2 fractions, once weekly combined with EBRT (52), or 10 Gy at 10 mm × 1 fraction or 7 Gy at 10 mm × 2 fractions, combined with EBRT (53)		1. Netherlands multicenter, Homs <i>et al.</i> PMID 15500894 (50) 2. Systematic review, Fuccio <i>et al.</i> PMID 28104297 (51) 3. IAEA, Rosenblatt <i>et al.</i> PMID: 20950882 (52) 4. ABS Guidelines, Gaspar <i>et al.</i> PMID: 9212013 (53)
	Re-irradiation	Avoid brachytherapy until pandemic resolves/resources become available due to increased risk of staff exposure from droplets. Consider conformal EBRT.	Intraluminal HDR monotherapy: 5–7 Gy at 5 mm × 5–6 fractions (54), or 10–17.5 Gy at tumor depth in 3 fractions (limit mucosa to ≤ 12 Gy per fraction) (55)		1. Saint Louis Hospital, Paris, Wong Hee Kam <i>et al.</i> PMID 25906950 (54) 2. Memorial Sloan Kettering Cancer Center, New York, Taggar <i>et al.</i> PMID 29496425 (55)
Hepato-biliary cancers	Hilar Cholangiocarcinoma (bridge to transplant) Definitive	1. Avoid brachytherapy until pandemic resolves/resources become available due to increased risk of staff exposure from droplets. Consider conformal EBRT. 2. If patient is COVID-19 +/PUI/IL, then consider continuing EBRT instead of brachytherapy boost	Intraluminal boost after EBRT: Mayo Clinic Protocol: 45 Gy/30 fractions EBRT with concurrent 5FU and 20–30 Gy intraluminal brachytherapy (56)	If brachytherapy needs to be used, then consider a single fraction regimen Boost after EBRT: 9.3 Gy × 1 (1.0 cm radially beyond the catheter) (57)	1. Mayo Clinic, Rochester, Rea <i>et al.</i> PMID 16135931 (56) 2. Mayo Clinic, Rochester, Deufel <i>et al.</i> PMID: 29776892 (57)
	Palliative unresectable malignant biliary obstruction or hepatocellular carcinoma (not for transplant) and metastatic lesions	Avoid brachytherapy until pandemic resolves/resources become available due to increased risk of staff exposure from droplets. Consider conformal EBRT (58–60)	Interstitial LDR malignant biliary obstruction: I-125 impregnated stents, 30–60 Gy at 15 mm (61,62) Interstitial HDR hepatocellular carcinoma: 15–25 Gy 1 fraction (63) Interstitial HDR liver metastases: 15 Gy × 1 for breast cancer metastases 20 Gy × 1 for nonbreast secondary liver cancers (64)		1. Multicenter phase II study, Hong <i>et al.</i> PMID 26668346 (58) 2. Univ of Rochester, Stereotactic Hypofractionated RT. Katz <i>et al.</i> PMID 22172906 (59) 3. Systematic review. Rim <i>et al.</i> PMID 29233562 (60) 4. Systematic review, Xu <i>et al.</i> PMID 29075881 (61) 5. Multicenter study, China, Zhu <i>et al.</i> PMID: 29331343 (62) 6. Otto von Guericke University, Germany. Mohnike <i>et al.</i> PMID: 20056348 (63) 7. University Hospital Magdeburg, Magdeburg, Germany, Hass <i>et al.</i> PMID 31522972 (64)

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Disease site	Indication	Practical implementation considerations during pandemic	Common dose/fractionation	Suggested dose/fractionation during pandemic	References
Rectal cancer	Preoperative or definitive	<ol style="list-style-type: none"> <li>1. Avoid brachytherapy until pandemic resolves/resources become available due to increased risk of staff exposure from possible fecal spread. Consider conformal hypofractionated EBRT.</li> <li>2. If patient is COVID-19 +/-PUI/ILI, then consider change to hypofractionated EBRT instead of brachytherapy boost.</li> </ol>	<p>Intraluminal HDR monotherapy (pre-op): 26 Gy in 4 fractions prescribed to target volume (65,66)</p> <p>Intraluminal HDR boost after chemoradiation (inoperable) (67): 40 Gy in 16 fractions EBRT + 10 Gy at 10 mm depth × 3 fractions(68), or 39 Gy in 13 fractions EBRT+ 7 Gy to volume × 3 fractions (69,70), or 60 Gy in 30 fractions + 5 Gy at 10 mm from applicator surface x 1 fraction(71)</p>		<ol style="list-style-type: none"> <li>1. McGill University Health Center, Canada, Hesselager <i>et al.</i> PMID: 23461819 (65)</li> <li>2. McGill University Health Center, Canada, Te Vuong <i>et al.</i> PMID 17714925 (66)</li> <li>3. Systematic review. Buckley <i>et al.</i> PMID 28816137 (67)</li> <li>4. McGill University Health Center, Canada, Garant <i>et al.</i> PMID: 31476417 (68)</li> <li>5. HERBERT study, Rijkmans <i>et al.</i> PMID: 28366579 (69)</li> <li>6. HERBERT study, Rijkmans <i>et al.</i> PMID: 30935576 (70)</li> <li>7. Danish Colorectal Cancer Center South, Denmark, Appelt <i>et al.</i> PMID: 26156652 (71)</li> </ol>
Sarcoma	BRT monotherapy or boost	<ol style="list-style-type: none"> <li>1. Delay brachytherapy until pandemic resolves/resources become available. Consider EBRT.</li> <li>2. If patient is COVID-19 +/-PUI/ILI during EBRT, then consider continuing EBRT instead of brachytherapy boost.</li> </ol>	<p>Interstitial HDR monotherapy (post-op, high-grade &lt; 10 cm, negative margins): 30–50 Gy/8–14 fractions/4–7 days twice daily (72)</p> <p>Interstitial HDR monotherapy (Post-op, high-grade, close or positive margins margins): 36 Gy/6 fractions/3 days BID (73)</p> <p>Interstitial HDR boost (Post-op, low-grade deep &gt; 5 cm or high-grade &gt; 10 cm, negative margins): 12–20 Gy/2–3 days + EBRT 45–50 Gy EBRT Total Dose ≥ 60 Gy (72)</p> <p>Interstitial HDR boost (Post-op, positive surgical margins): 12–20 Gy/2–3 days + EBRT 45–50 Gy EBRT Total dose ≥ 65–70 Gy (72,74) BRT 16 Gy/2 days + EBRT 45 Gy EBRT (75)</p>		<ol style="list-style-type: none"> <li>1. ABS STS recommendation, Naghavi <i>et al.</i> PMID: 28342738 (72)</li> <li>2. National Cancer Center Hospital, Japan, Itami <i>et al.</i>, PMID: 20692211 (73)</li> <li>3. Martínez-Monge <i>et al.</i> Univ. Navarre, Spain PMID: 21353160 (74)</li> <li>4. AIIMS, India, Sharma <i>et al.</i>, PMID: 25861894 (75)</li> </ol>

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Table 1 (continued)

Disease site	Indication	Practical implementation considerations during pandemic	Common dose/fractionation	Suggested dose/fractionation during pandemic	References
Head and neck definitive reirradiation	Definitive/boost oral cavity/oropharynx, Boost nasopharynx or any re-irradiation	1. Avoid brachytherapy until pandemic resolves/resources become available due to increased risk of staff exposure from droplets. Consider conformal EBRT 2. If patient is COVID-19 +/-PUI/ILI, then consider continuing EBRT instead of brachytherapy boost	Interstitial HDR monotherapy oral cavity/oropharynx: 35–44 Gy/10–11 fractions/5–5.5 days/twice daily (76–78) Interstitial HDR boost oral cavity/oropharynx: 21–30 Gy/7–10 fractions/3–5 days + EBRT 40–50 Gy (76–78) Interstitial HDR boost nasopharynx: 12–18/4–6 fractions/2–3 days + EBRT 60–70 Gy (76–78) Interstitial HDR monotherapy re-irradiation: 30–40 Gy/10 fractions/5 days/twice daily (79,80)		1. ABS Task Group Report, Takácsi-Nagy <i>et al.</i> PMID: 27592129 (76) 2. GEC-ESTRO- ACROP recommendations, Kovacs <i>et al.</i> PMID: 27889184 (77) 3. GEC-ESTRO recommendations, Mazon <i>et al.</i> PMID: 19329209 (78) 4. Jupiter Hospital, India, Bhalavat <i>et al.</i> , PMID: 30479619 (79) 5. Sana Klinikum Offenbach GmbH, Germany, Tselis <i>et al.</i> , PMID: 21129799 (80)
Brain tumors	Primary brain tumors or brain metastases Adjuvant	Avoid brachytherapy until pandemic resolves/resources become available. Consider fractionated EBRT (glioma) or preoperative or postoperative SRS/SRT (brain metastases)	Interstitial LDR (gliomas): 50–65 Gy (81,82) Interstitial LDR (brain metastases): 60–70 Gy (83)		1. Review, Barbarite <i>et al.</i> PMID: 27180560 (81) 2. Review, Nachbichler <i>et al.</i> PMID: 29393178 (82) 3. Review, Mahase <i>et al.</i> PMID: 30850332 (83)
Lung cancers	Palliative  Post-transplant stenosis	Avoid brachytherapy until pandemic resolves/resources become available due to increased risk of staff exposure from droplets. Consider short-course EBRT. Avoid brachytherapy until pandemic resolves/resources become available due to increased risk of staff exposure from droplets.	Endobronchial HDR: 10 Gy at 10 mm/1 fraction, or 30 Gy at 1 cm/6 fractions (84)  Endobronchial HDR: 7–10 Gy at 10 mm/1–2 fractions/2 weeks (85)		1. ABS recommendations Stewart <i>et al.</i> PMID: 26561277 (84)  1. Rabin Medical Center, Israel. Allen <i>et al.</i> , PMID: 22381651 (85)
Uveal Melanoma	Definitive		70 to 100 Gy to the tumor apex over 5–7 days (86)	No change	1. ABS recommendations, Simpson <i>et al.</i> PMID: 24373763 (86)

HDR = high-dose-rate; LDR = low-dose-rate; BRT = brachytherapy; EBRT = external beam radiotherapy; PMID = Pubmed identifier; SRS/SRT = stereotactic radiosurgery/stereotactic radiotherapy; COVID-19 +/-PUI/ILI = influenza-like illness (ILI), persons under investigations (PUI) for COVID-19 with test results pending, and patients who may have tested positive for COVID-19 (COVID-19 +).

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