

1 **Supplementary material has been published as submitted. It has not been copyedited,**
2 **or typeset by Acta Oncologica**

3 In connection with JANE-2, the following patient information sheets were developed:
4

- 5 - Patient information – Nuclear Medicine
- 6 - Patient information – Radiomics
- 7 - Patient information – Innovative Radiotherapies
- 8 - Patient information – Innovative Surgery
- 9 - Patient information – Physical Methods of Ablation
- 10 - Patient information – Cell Therapies
- 11 - Patient information – Ex-vivo Testing of Agents
- 12

13 By developing these information sheets, we aim to enhance information to patients about highly
14 advanced technologies within cancer treatment.

15 The patient information sheets were developed by experts within each technology in collaboration
16 with patient representatives.

17 The content of these information sheets may be downloaded, shared and translated to other
18 languages. Referencing to this original material is required.
19
20

21 **Supplementary S1: Patient information – Nuclear Medicine**

22

23 Nuclear medicine is a medical area in which pharmaceuticals that emit radiation
24 (radiopharmaceutical) are used for diagnosis and treatment by visualising molecular and functional
25 changes.

26 Nuclear medicine therapy is a non-invasive treatment that offers people living with cancer a
27 targeted and personalised care with minimal side effects.

28

29

30 **Application of technology (what does it do)**

31 A radiopharmaceutical is a combination of a *pharmaceutical* and a *radionuclide* (radioactive
32 isotope) that emits radiation. These pharmaceuticals target a specific organ, tissue, or cellular
33 receptor in the body. The radionuclide emits radiation in the form of photons that could be used for
34 imaging by means of PET or SPECT devices (diagnosis), or in the form of electrons and alpha
35 particles for treatment (therapy). The combination of diagnosis and therapy with the same molecule
36 brings the word theranostic or radiotheranosis, a technology allowing to “see what you treat and
37 treat what you see”. The molecules used specifically seek out and stick to cancer cells. Once
38 attached, radiation enters the cancer cell, damages its DNA and thereby stops the cancer cell from
39 growing or cause it to die.

40

41 **Who does it, where can you find it?**

42 The diagnosis and the administration of therapy must be done in highly specialised departments
43 within a hospital (Nuclear Medicine Departments) or dedicated centres with the corresponding
44 authorisation to manipulate and administer radioactive sources, to assure safety conditions in the
45 administration and reduce the radiation dose to the public.

46 The administration is performed by a nuclear medicine specialist who works in close collaboration
47 with radiopharmacists, medical physicists, nurses, and medical technicians. The appropriate
48 treatment is determined by the referring physician who may be an oncologist, endocrinologist,
49 hepatologist or gynaecologist, depending on the type of tumour.

50 Information about departments or centres performing this procedure is provided by the referring
51 physician. Furthermore, this information may be available on websites of the hospitals and
52 dedicated centres.

53

54 **Inpatient or outpatient?**

55 The administration of the treatment is planned as an inpatient or outpatient procedure depending on
56 the type of radionuclide, radiation dose and national safety regulations.

57 In the *outpatient treatment*, the patient is discharged the same day. It is used for lower radiation
58 doses or short-lived isotopes (like lutetium-177 and radium-223).

59 *Inpatient treatment* is required for higher radiation doses or longer-lived isotopes. In these cases, it
60 is necessary to stay in shielded hospital rooms until radiation levels are safe (e.g. treatments with
61 iodine-131).

62 Upon discharge, a set of recommendations are provided to ensure minimal radiation dose to friends,
63 family and caregivers in the following days.

64 There is a growing trend toward outpatient treatments as therapies become safer and more efficient.

65

66 **Who may benefit?**

67 Currently, this therapeutical option is being used in thyroid cancer, neuroendocrine tumours,
68 prostate cancer, liver cancer (hepatocarcinoma), breast cancer, skin cancer, kidney cancer, colorectal
69 cancer, pancreatic cancer and leukaemia. Most of the treatments are currently performed at late-
70 stage disease, meaning metastatic disease.

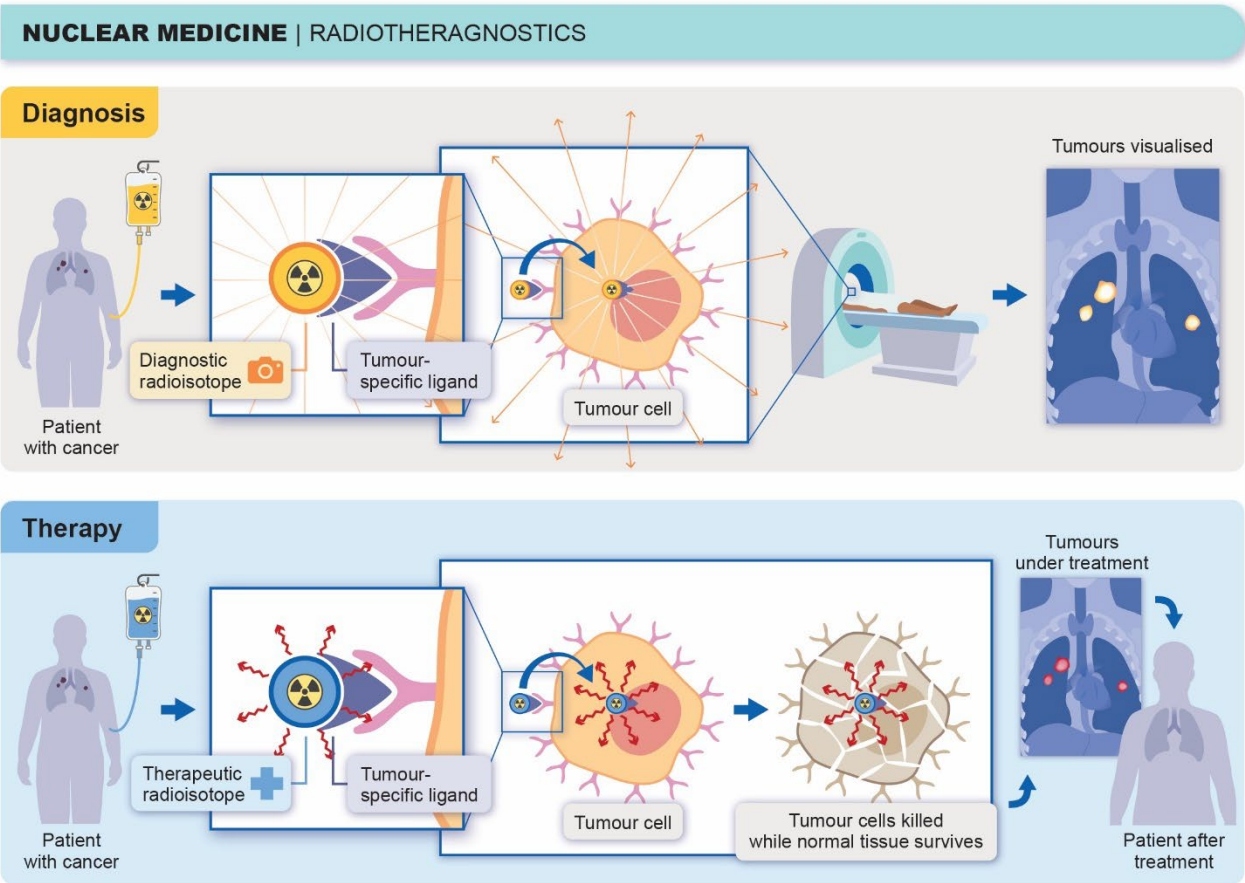
71

72 **Side effects**

73 Side effects differ between the treatments and may range from very mild and transient to more
74 severe. Side effects depend on where the target of treatment is. If the treatment targets the thyroid
75 gland, transient symptoms such as pain from the throat are likely. Treatment may necessitate
76 hospitalisation for some days if radiation levels are high. Another example is ¹⁷⁷Lu-PSMA therapy,
77 where common side effects are dry mouth, tiredness, nausea and low blood counts.

78 Because side effects highly depend on the target of treatment and the pharmaceutical used, relevant
79 side effects will always be explained by the treating physician prior to treatment at the hospital, and
80 the patient will be monitored closely by the medical team.

81



82

83 **Figure 1:** Nuclear medicine therapy employs radioisotopes attached to specific molecules to deliver
84 radiation dose to the tumour. Radiotheranostics is a particular form of nuclear medicine in which the
85 same specific molecule is used for diagnosis and for treatment by changing the attached
86 radioisotope: 1) For diagnosis, a radioisotope that emits photons is employed. 2) For therapy, the
87 radioisotope is electron or alpha particle emitter, causing irradiation and destruction of tumour cells.

88

89 **Main future forecast**

90 Nuclear medicine therapy is used for treatment of thyroid cancer, neuroendocrine tumours, prostate
91 cancer, hepatocarcinoma, and pancreatic cancer. It is not first line option or standard of care (except

92 for the thyroid cancer in combination with surgery), but these treatments are advancing in treatment
93 options through the scientific evidence generated in clinical trials.

94 The approach in which specific molecules seek out and stick to cancer cells is expanding. Instead of
95 targeting only the cancer cells, new treatments are being designed to also target the tumour's
96 surrounding environment. This includes the blood vessels that feed the tumour, supportive cells
97 known as cancer-associated fibroblasts, the structural tissue around the tumour, and even certain
98 immune cells. By targeting these additional components, the tumour may be weakened more
99 effectively.

100 Another exciting development is the combination of radionuclide treatments with other established
101 cancer therapies, e.g. chemotherapy. Early research and clinical trials are exploring how these
102 targeted radiation treatments might work together with chemotherapy, drugs that make cancer cells
103 more sensitive to e.g. radiotherapy, and immunotherapy. The goal is to enhance treatment
104 effectiveness and improve outcomes for patients.

105 Overall, these advances represent an important step forward in making cancer treatment more
106 precise and successful.

107

108 **Useful links**

109 Patient associations or institutions dedicated to improving the access to theranostics:

110 <https://www.oncidiumfoundation.org/patient-support/>

111 <https://www.aboutkidshealth.ca/131i-mibg-therapy>

112 Information about clinical trials:

113 <https://www.theranostictrials.org>

114 <https://euclinicaltrials.eu/search-for-clinical-trials/?lang=en>

115 Educational material (from radiopharmaceutical and medical devices companies):

116 PLUVICTO: <https://www.pluvicto-hcp.com/psma-positive-mcrpc/resources>

117 LUTATHERA: <https://us.lutathera.com/patient-support/useful-resources>

118 TheraSphere: [https://www.bostonscientific.com/en-US/medical-specialties/interventional-](https://www.bostonscientific.com/en-US/medical-specialties/interventional-radiology/interventional-oncology/therasphere/patient-education.html)
119 [radiology/interventional-oncology/therasphere/patient-education.html](https://www.bostonscientific.com/en-US/medical-specialties/interventional-radiology/interventional-oncology/therasphere/patient-education.html)

120 Sirtex: <https://www.sirtex.com/us/patients/resources/educational-materials/>
121 OncoSil: <https://www.oncosil.com/resource-library/?resource-category=patient-resources>
122 Radiation protection from the International Atomic Energy Agency:
123 <https://www.iaea.org/resources/rpop/patients-and-public/nuclear-medicine>

124

125 **Keywords**

126 *Nuclear medicine therapy* is known by several names: Radiotheranostics, Targeted Radionuclide
127 Therapy, Theranosis, Radiopharmaceutical Therapy, Molecular Radiotherapy, Radioisotope
128 Therapy, Nuclear Medicine Therapy, or Peptide Receptor Radionuclide Therapy (PRRT),
129 Radioligand Therapy, Radionuclide therapy.

130 *Radionuclides*: radioactive isotopes, radioisotopes, imaging radioisotopes, therapeutic radioisotopes

131 *Emitting particles from decays*: Alpha particles, beta particles, imaging radioisotopes, therapeutic
132 radioisotopes.

133

134

135 **Supplementary S2: Patient information – Radiomics**

136

137 Radiomics uses computers to measure patterns in medical images (CT, MRI, PET, ultrasound, etc.).
138 Today, it is mainly used in research, but in the future, it may help doctors make more personalised
139 medical decisions.

140

141 **What is radiomics?**

142 A computer analyses a selected area (e.g. a tumour) on a scan (i.e. a medical image) and measures
143 properties such as shape, texture and brightness patterns. These measurements are called “radiomics
144 features”. To put it simply, radiomics means turning medical images into numbers.

145

146 **Why are researchers studying radiomics?**

- 147 - To describe a disease more precisely using information already present in medical images.
- 148 - To support diagnosis and estimate how a disease may behave over time (prognosis).
- 149 - To help choose or adapt treatments and monitor how well a treatment works.

150

151 **How does radiomics work?**

- 152 1. You have medical imaging as part of your usual care.
- 153 2. A specialist (or dedicated software) marks the area of interest on the image.
- 154 3. A computer extracts many measurements (radiomics features).
- 155 4. Researchers develop and test a computer model (often using artificial intelligence) on data
156 from many patients.

157

158 **Is radiomics used in routine care today?**

159 In most hospitals, radiomics is still a research tool. Before it can be used safely in everyday clinical
160 care, radiomics models must be carefully tested in large studies and validated across different
161 scanners, hospitals and patient populations.

162

RADIOMICS

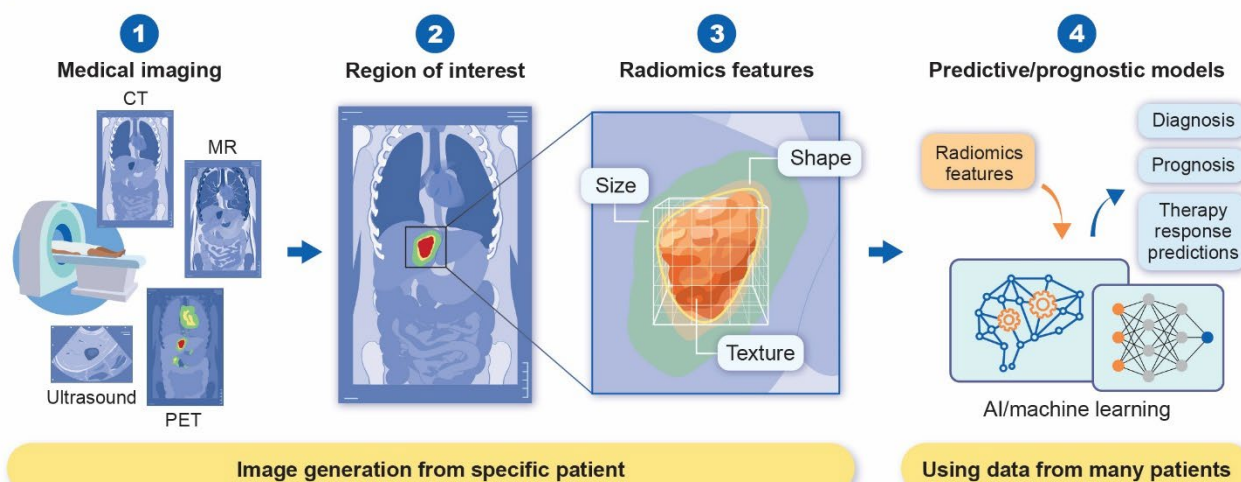


Figure 1. Typical steps in a radiomics analysis workflow: 1) Image/scan acquisition from different medical imaging modalities, either computed tomography (CT), magnetic resonance imaging (MRI), positron emission tomography (PET) or ultrasound. 2) Focus on the region of interest (e.g. the tumour). 3) Extraction of features from the region of interest such as characteristics of size, shape or texture. 4) Integration of numerous radiomic features, extracted from several patients, into AI/machine learning models to make prognosis or predictions.

What could be the benefits?

- More information from your scans, beyond what the human eye can easily see.
- Additional support for doctors when combining information from imaging, pathology and clinical examinations.
- Earlier prediction of how a disease may respond to a treatment.

What are the current limitations?

- Results can change if scan settings or image quality differ.
- A model that works well in one hospital may not perform equally well elsewhere (the model needs to be properly validated to work everywhere).

- Radiomics does not replace your doctors' judgement; it is an additional decision-making support tool.

Your scan and your data

Radiomics usually uses scans that were already performed as part of your care, so it does not need any extra scans. When radiomics is used in research, patient data are handled under strict ethical and legal regulations. Personal identifiers such as your name and hospital number are removed or replaced before your images are examined.

What is needed for the future?

Before radiomics can be widely used in routine care, researchers must ensure that results are reliable and comparable between hospitals. This requires not only large amounts of data, but also shared standards in the way the images are acquired, processed and analysed. International collaboration, data sharing and continuous improvement of methods are key steps toward safe and meaningful clinical use of radiomics.

Questions you can ask your care team

- Is radiomics being used for my condition here, or only in research?
- If it is part of a study, what data will be used and how will it be protected?
- If I do not want my images to be used for radiomics analysis, will there be any consequences on my current treatment?
- Could radiomics results influence my treatment plan today?

Glossary

Artificial intelligence (AI): The ability of computer systems to perform tasks that usually require human intelligence, such as reasoning, decision-making, or problem-solving.

Machine learning: A type of AI where computers learn from examples.

Radiomics features: Numbers that describe an image region (for example shape or texture).

209 *Validation:* Testing a model on new, independent data to check that it works reliably.

210

211 **More information**

212 Cancer Image Europe – Radiomics: <https://cancerimage.eu/partners/radiomics>

213 Euro-BioImaging: <https://www.eurobioimaging.eu/>

214 Radiomics.bio: <https://radiomics.bio/>

215 Open-access review article (PubMed Central): <https://pmc.ncbi.nlm.nih.gov/articles/PMC7193906/>

216 **Supplementary S3: Patient information – Innovative Radiotherapies**

217 Radiotherapy, or radiation oncology, is a clinical discipline and represents a cornerstone of cancer
218 therapy. It is used alone or in combination with other treatments such as surgery and systemic
219 therapy. Radiotherapy originated over a century ago and continues to evolve. It is widely used
220 across a broad range of cancer types.

221

222 **What is radiotherapy, and what does “innovation” mean?**

223 Radiotherapy is a cancer treatment that uses ionising radiation to damage the DNA of tumour cells to
224 prevent them from growing and dividing.

225 “Innovative radiotherapy” refers to modern technologies and clinical workflows that aim to improve
226 the therapeutic ratio, meaning achieving the desired effect on the tumour while reducing side effects
227 in healthy tissues.

228 Innovation in radiotherapy includes better imaging, more accurate targeting, more sophisticated
229 treatment planning, and improved control of tumour motion, adjusting for movement of the tumour
230 as the patient breathes (e.g. lung tumour). Advanced techniques are now used to track or account for
231 this motion in real-time. This ensures that the radiation is delivered precisely to the tumour while
232 sparing healthy tissues. Furthermore, clinicians now have the ability to adapt plans when anatomy
233 changes, and to ensure rigorous quality assurance to keep treatments safe and reproducible.

234 In some situations, innovation within radiotherapy has also made treatment more convenient, for
235 example by safely delivering fewer sessions, when clinically appropriate. Breast cancer is one such
236 example, and in many cases treatment is now achieved with just 5-15 sessions (sometimes completed
237 in just one week) instead of the traditional 25–30 daily treatments during a span of 5 weeks.

238

239 **How does a course of radiotherapy usually work?**

240 Most radiotherapy pathways include a planning phase and a delivery phase. It is delivered over one
241 or more sessions (also called “fractions”). Planning usually begins with a simulation-appointment,
242 where imaging (commonly CT, sometimes combined with MRI or PET) is used to identify the tumour
243 area and nearby organs at risk. Immobilisation devices may be used to help you keep the same position
244 each day. A multidisciplinary team (radiation oncologists, medical physicists, radiation therapists, and

245 imaging specialists) then creates a treatment plan to deliver the prescribed dose as precisely as
246 possible.

247 During treatment delivery, accuracy is checked repeatedly. Many innovations are designed to reduce
248 uncertainties: They verify tumour position before each session, account for motion (such as
249 breathing), and in some cases update the plan during the course if the anatomy changes. These steps
250 may not be obvious to patients, but they are central to improving safety and outcomes.

251

252 **Who may benefit?**

253 Radiotherapy is used across different cancer diagnoses and may be used both to cure cancer and to
254 treat symptoms (e.g. pain) from local tumours.

255 Innovative radiotherapy approaches are most relevant when increased precision meaningfully
256 changes the balance between tumour control and side effects. Examples include tumours located close
257 to critical organs (where small differences in dose can matter), tumours in areas that can move (where
258 managing movement helps make treatment more accurate), and selected scenarios suitable for
259 stereotactic radiotherapy. Children and young adults may benefit when reducing dose to healthy
260 tissues is particularly important to lower the risk of late effects. Innovation is also important in re-
261 irradiation, when treatment is needed in an area that has already received radiotherapy and dose limits
262 are strict.

263 Particle therapy may be considered in selected indications where dose reduction to healthy tissues
264 could lower the risk of late toxicity, or where established protocols support its use. Particle therapy is
265 therefore recommended for some patients, but not for all: doctors will recommend it when it is
266 expected to offer a clear advantage over standard radiotherapy, taking into account the patient's
267 clinical circumstances.

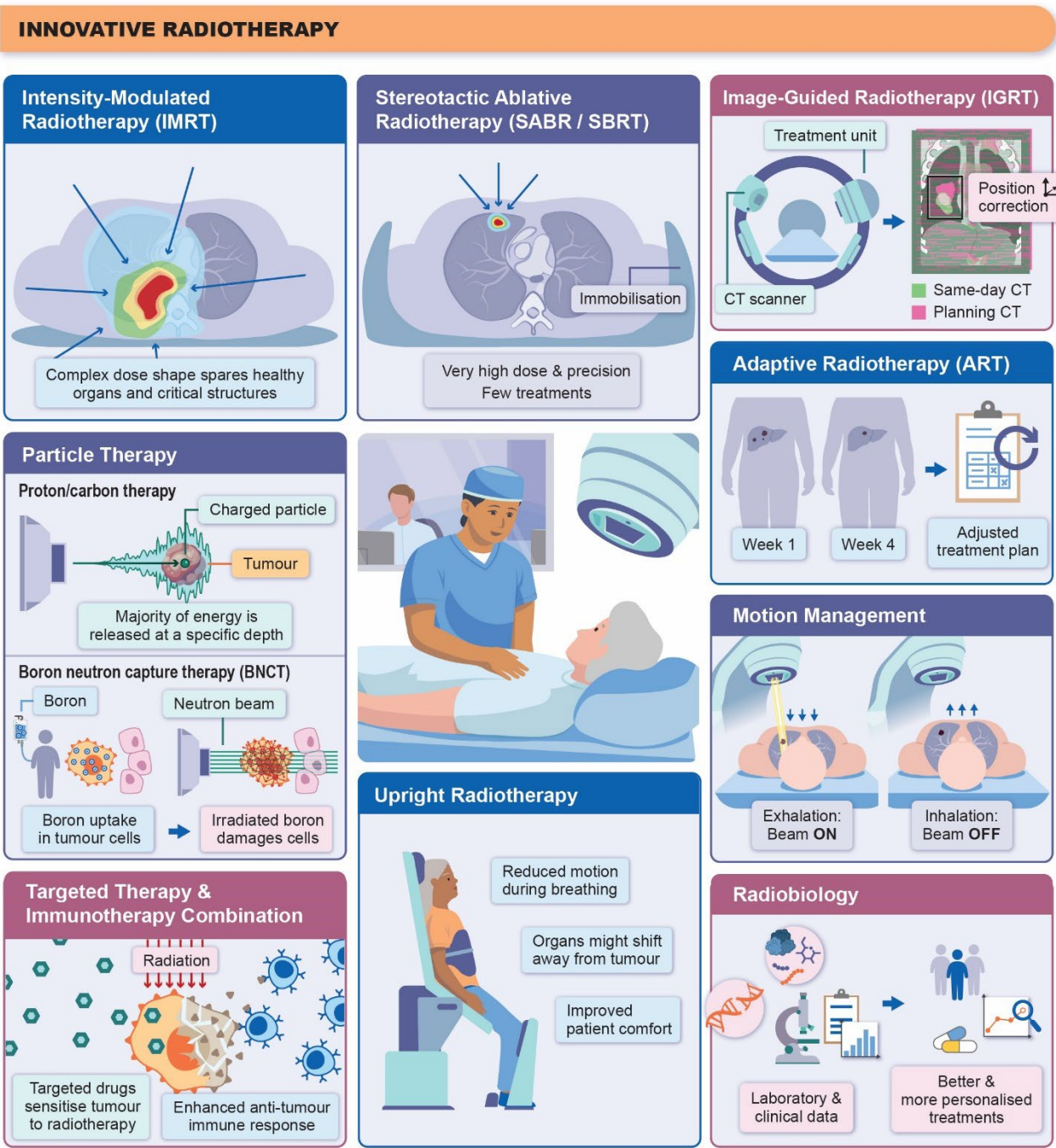
268

269 **Side effects**

270 The treatment itself is typically painless. Only the area targeted with radiation therapy is affected, and
271 side effects are therefore specific to the dose and the specific treatment area, as well as treatment type.
272 For example, treatment of tumours in the throat generally leads to more serious side effects including
273 pain in the throat and swallowing difficulties. In contrast, treatment of the breast is associated with
274 milder side effects such as erythema of the skin in the breast area.

275 Due to variation, relevant side effects will be explained by the treating physician prior to treatment at
276 the hospital.

277



278

279 **Figure 1:** Overview of different types of innovative radiotherapy and related treatment approaches,
280 highlighting how radiotherapy is becoming more precise and personalised, and limiting damage to

281 healthy tissues. The most suitable technique depends on the type, size and location of the tumour, as
282 well as the aim of treatment.

283

284 **What does innovative radiotherapy do in practice?**

285 Most patients receive “photon” radiotherapy (high-energy X-rays). Innovative radiotherapy focuses
286 on precision and personalisation. Techniques such as IMRT/VMAT shape and modulate the dose so
287 it conforms closely to the target, helping spare sensitive adjacent organs. Image-guided radiotherapy
288 (IGRT) uses imaging immediately before (and sometimes during) each session to confirm positioning,
289 improving day-to-day accuracy.

290 A frequent challenge is tumour and organ motion. For cancers in the chest and upper abdomen (for
291 example lung or liver), the target can move with breathing. Motion management approaches, such as
292 4D imaging, gating, tracking, or surface guidance, help reduce unnecessary “safety margins” by
293 ensuring that the dose is delivered when the tumour is in the expected position. This can improve
294 protection of healthy tissues while maintaining tumour coverage.

295 In carefully selected cases, stereotactic radiotherapy (SRT/SBRT) delivers very precise, high doses
296 in a small number of sessions (often 1–5). It is used for specific situations such as certain early-stage
297 tumours or limited metastatic disease (“oligometastatic” disease) when clinically appropriate and
298 when normal tissue constraints can be respected.

299 Another important innovation is adaptive radiotherapy, where the treatment plan can be updated if
300 anatomy changes during the course (for example weight loss, tumour shrinkage, or changes in organ
301 filling). In some centres, MR-guided radiotherapy improves soft-tissue visualisation and may allow
302 plan adaptation during treatment for selected tumour sites.

303

304 **Particle therapy: Protons and carbon ions**

305 Some centres offer radiotherapy with protons or carbon ions (often referred to as “hadrontherapy”).
306 These particles deposit most of their energy at a specific depth, which may reduce dose beyond the
307 tumour compared with photons. This characteristic can be particularly relevant when the tumour is
308 close to organs where dose should be minimised, and when long-term side effects are a major concern.
309 In this context, one of the main indications for *proton therapy* is in most paediatric solid tumours. For
310 these patients, reducing long-term side effects of treatment is a key goal. Similarly, in certain brain

311 tumours and head and neck cancers, proton therapy can reduce specific toxicities such as
312 neurocognitive effects in the case of brain tumours, and swallowing difficulties and dry mouth in the
313 case of head and neck cancer.

314 Carbon ions also have distinct properties, which may be relevant for selected indications under
315 defined protocols (i.e. the base of the skull). Because these treatments require complex, dedicated
316 infrastructure and specialised expertise, they are not available in every country or region.

317

318 **Emerging therapies (highly specialised): BNCT**

319 Boron neutron capture therapy (BNCT) can be considered an innovative form of radiotherapy, but it
320 is highly specialised and not widely available. BNCT combines a boron-containing drug (intended to
321 accumulate preferentially in tumour cells) with irradiation using neutrons; the interaction can produce
322 very localised tumour cell damage. In most settings, BNCT is offered within clinical trials or tightly
323 governed clinical programmes, and for selected indications based on specific eligibility criteria.
324 Patients interested in BNCT should discuss with their clinical team whether it is relevant for their
325 case and whether referral to a specialised centre is appropriate.

326

327 **Infrastructure: Who provides it, where is it available, and how can patients access it?**

328 Across Europe, access to innovative radiotherapy is commonly organised in a *two-level system*.

329 *At the first level*, many hospital radiotherapy departments and comprehensive cancer centres can
330 provide advanced photon radiotherapy (intensity-modulated radiation therapy (IMRT) and volumetric
331 modulated arc therapy (VMAT)), daily image guidance, and in many cases stereotactic radiotherapy
332 (SBRT). This latter delivers high-dose radiation to small tumours in just 1 to 5 daily sessions and can
333 be performed using standard radiotherapy equipment. For most patients, evaluation and treatment
334 occur within standard oncology referral pathways, close to where they live, and decisions are made
335 by a multidisciplinary team.

336 *At the second level*, some technologies are more centralised because they require highly specialised
337 infrastructure. MR-guided radiotherapy is available only at a limited number of centres.
338 Hadrontherapy is delivered in dedicated hubs that typically operate with structured referral criteria
339 and eligibility assessment. According to recent European mapping (2024), approximately 27 clinical
340 proton centres and 4 carbon-ion centres exist; additional proton facilities are planned, but access

341 remains geographically uneven. This means that the practical question for patients is often whether
342 the most suitable technique can be delivered locally, or whether a referral to a specialised centre is
343 appropriate.

344 If your team considers that a specialised technology may be relevant, they can initiate a referral for
345 assessment at an appropriate hub. In some situations, this may involve cross-border referral pathways,
346 depending on national rules, reimbursement conditions, and local clinical arrangements.

347

348 **Important note (availability and eligibility)**

349 Availability of technologies, referral pathways, and eligibility criteria can change over time and may
350 differ between countries. Decisions should always be made with the treating multidisciplinary team,
351 based on clinical appropriateness, expected benefit, and the best available evidence.

352

353 **Keywords (for patient searching)**

354 IMRT, VMAT, IGRT, SBRT/SRT, motion management, adaptive radiotherapy, MR-guided
355 radiotherapy, proton therapy, carbon-ion therapy, hadrontherapy, BNCT, referral pathways, quality
356 assurance, patient-reported outcomes.

357

358 **Suggested questions to ask your team**

- 359 1. Could an advanced technique (such as IMRT/VMAT, SBRT, adaptive or MR-guided
360 radiotherapy) be relevant for my tumour type and location?
- 361 2. Is it available locally, or should I be referred to a specialised hub?
- 362 3. If particle therapy or an emerging approach is being considered, what evidence supports its
363 use for my situation, and is it offered under a protocol or clinical trial?
- 364 4. What are the expected benefits and risks, including potential late effects, and what follow-up
365 is planned?

366

367 **Useful links for Patients' Associations**

368 *Belgium*

369 Stichting tegen Kanker: <https://kanker.be>

370 Kom op tegen Kanker: <https://www.komoptegenkanker.be>

371 Vlaams Patiëntenplatform vzw (Flanders): <https://vlaamspatientenplatform.be>

372 European Cancer Patient Coalition (ECPC): <https://ecpc.org>

373

374 *Lithuania*

375 POLA: <https://pola.lt/>

376

377 *Italy*

378 AIMaC – Associazione Italiana Malati di Cancro: <https://www.aimac.it/>

379 FAVO - Federazione Italiana delle Associazioni di Volontariato in Oncologia: <https://www.favo.it/>

380 LIILT – Lega Italiana per la Lotta contro i Tumori: <https://www.lilt.it/>

381 Europa Donna Italia: <https://www.salutedonnaonlus.it/>

382 Europa Uomo Italia: <https://www.europauomo.it/>

383 Salute Donna Onlus: <https://www.salutedonnaonlus.it/>

384

385 *Norway*

386 Kreftforeningen : <https://kreftforeningen.no/>

387

388 *Spain*

389 Asociación Española Contra el Cáncer (clear patient-focused cancer information, psychosocial

390 support and guidance on access to care):

391 <https://www.contraelcancer.es>

392 Grupo Español de Pacientes con Cáncer (focused on patient rights, equitable access to innovation

393 and patient advocacy):

394 <https://www.gepac.es>

395 Asociación de Madres y Padres de Niñas y Niños con Cáncer de la Comunidad Valenciana

396 (Parents’ association supporting children and adolescents with cancer in the Valencian Community)

397 Inicio – Aspanion:

398 <https://aspanion.es/>

399

400 *Sweden*

401 Cancerfonden (patient-focus on cancer information, psychosocial support and guidance on access
402 to care):
403 <https://www.cancerfonden.se/>

404 Regionala Cancercentrum I samverkan (focused on cancer information, clinical studies, cancer care
405 guidelines, webinars, workshops and training):
406 <https://www.cancercentrum.se>

407 Nätverket mot cancer (umbrella organisation for cancer profiled patient organisations):
408 <https://www.natverketmotcancer.se>
409

410 **Supplementary S4: Patient information – Innovative Surgery**

411

412 **Making surgery safer and recovery faster**

413 Doctors now focus on preparing patients before, during, and after surgery. This is called enhanced
414 perioperative management.

415 Before surgery, patients may join prehabilitation programs that include light exercise, good
416 nutrition, and stress-reducing support. Being stronger before surgery helps lower complications and
417 speeds recovery.

418 Hospitals also use enhanced recovery after surgery (ERAS) routines, which guide pain control,
419 early movement, and when to start eating again. These routines improve recovery, especially in
420 patients with complex abdominal and pelvic cancers.

421 New digital tools, such as apps for reporting symptoms, may help teams respond earlier if problems
422 arise.

423

424 **New treatment options before and after surgery**

425 Cancer care is changing rapidly. Immunotherapy and targeted therapies are now standard for many
426 cancers.

427 More patients receive treatment before surgery (neoadjuvant therapy) to shrink tumours and target
428 potential microscopic spread of cancer tissue. This can make surgery easier, help save organs, or in
429 some cases avoid surgery altogether. It may also render technically inoperable tumours resectable.

430 Because patients respond differently, surgeons tailor decisions to how well each person's specific
431 cancer reacts. Researchers are developing better biomarkers—tests that help predict response and
432 guide treatment choices.

433

434 **High-tech tools that make surgery safer and more precise**

435 Robotic surgery and new imaging methods help surgeons clearly see the tumour during surgery.

436 Tools like fluorescent dyes, real-time scans, and intraoperative MRI help ensure the tumour is
437 removed safely.

438 In complex surgeries, doctors may use 3D models or augmented views created from a patient's own

439 scans. These tools improve planning and navigation during surgery.
440 Overall, these technologies reduce uncertainty and support precise cancer removal.

441

442 **Treatments that target specific areas of the body**

443 These cancer treatments focus on one specific part of the body instead of affecting the whole body.
444 For example, giving very strong doses of chemotherapy directly to an arm, a leg, or an organ. The
445 treatment works powerfully where the cancer is located, while the rest of the body gets fewer side
446 effects.

447 For cancers in the abdomen or the lining of the abdomen, there are methods where surgery is
448 followed by warm chemotherapy washing the abdominal cavity (HIPEC), or where chemotherapy is
449 sprayed in as a fine mist (PIPAC). New methods explore whether patients can receive chemotherapy
450 directly into the abdominal cavity over time at home through a small catheter placed during surgery.
451 For cancer that has spread to the liver, treatments that target the liver directly, such as percutaneous
452 hepatic perfusion (PHP) are available. This can help when standard whole-body treatment is not
453 enough.

454

455 **Gentle, targeted treatments that destroy tumours without major surgery**

456 Some cancers can be treated with ablative techniques, which destroy tumours using focused energy
457 rather than large surgery.

458 Examples include:

- 459 - *HIFU* – (high-intensity focused ultrasound) that heats and destroys tumours.
- 460 - *RFA* – (radio frequency ablation) small probe that delivers heat directly into the tumour.

461 These options are used in organs like the liver and prostate and may preserve organ function and
462 shorten recovery.

463 Researchers are also exploring how these methods can be combined with major surgery in selected
464 patients.

465

466 **How artificial intelligence (AI) helps making surgery safer**

467 AI can analyse scans, medical records, and test results to support care before, during, and after
468 surgery.

469 AI helps with:

- 470 - Planning – understanding tumour size and location.
- 471 - Guidance – offering real-time support during surgery.
- 472 - Recovery prediction – identifying who may need extra follow-up.

473 AI does not replace doctors but helps them make more informed decisions.

474

475 **Using big data to personalise cancer treatment**

476 Doctors can now combine information from DNA, proteins, imaging, and laboratory tests - an
477 approach called multi-omics. This helps build a more complete picture of each patient's cancer.

478 These insights help doctors:

- 479 - Understand tumour behaviour.
- 480 - Predict treatment response.
- 481 - Choose the safest surgical plan.

482 AI-enhanced tools can also identify which patients may benefit from complex surgery and support
483 robotic surgery through guidance and training.

484

485 **Where are these treatments available - and how patients can access them?**

486 Advanced surgical technologies are mainly offered in specialised cancer centres and university
487 hospitals. These centres have expert teams, advanced equipment, and access to clinical trials.

488 Treatment is delivered by multidisciplinary teams of surgeons, oncologists, radiologists,
489 anaesthesiologists, nurses, and rehabilitation specialists.

490 Patients usually access these treatments through referral to a centre of excellence. Some procedures
491 are available only in a few highly specialised units.

492 Patients may be referred by their doctor, request a second opinion, or join a clinical trial.

493

494 **Who might benefit from these advanced techniques?**

495 Many patients with cancer may benefit, especially those who:

- 496 - Have locally advanced tumours.
- 497 - Have limited metastatic disease.
- 498 - Require complex surgery where organ preservation matters.

499 Innovative surgery methods are used in cancers of the digestive system, gynaecologic organs,
500 urinary system, lungs, chest, and skin, but applications continue to expand across tumour types.

501 A multidisciplinary team evaluates each case to ensure treatments match the patient's health, cancer
502 type, and preferences.

503

504 **What can patients expect in the next five years?**

505 Most of these technologies already exist or are being developed in leading centres. Over the next
506 five years, patients may see:

- 507 - More personalised treatment: More precise use of scans, blood tests, and digital tools to
508 guide decisions.
- 509 - Better diagnostic tests: New biomarkers to detect cancer earlier and track treatment effects.
- 510 - Improved access: More collaboration across European countries to ensure equal access to
511 advanced treatments.
- 512 - A connected care system: Shared standards, high-quality training, and clearer patient
513 information across Europe.

514

515 **Useful links**

516 European Cancer Information Portal (EU-CiP) – provides patient-friendly, evidence-based
517 information on cancer diagnostics and treatment options across Europe:

518 <https://cancerinfoportal.eu/>

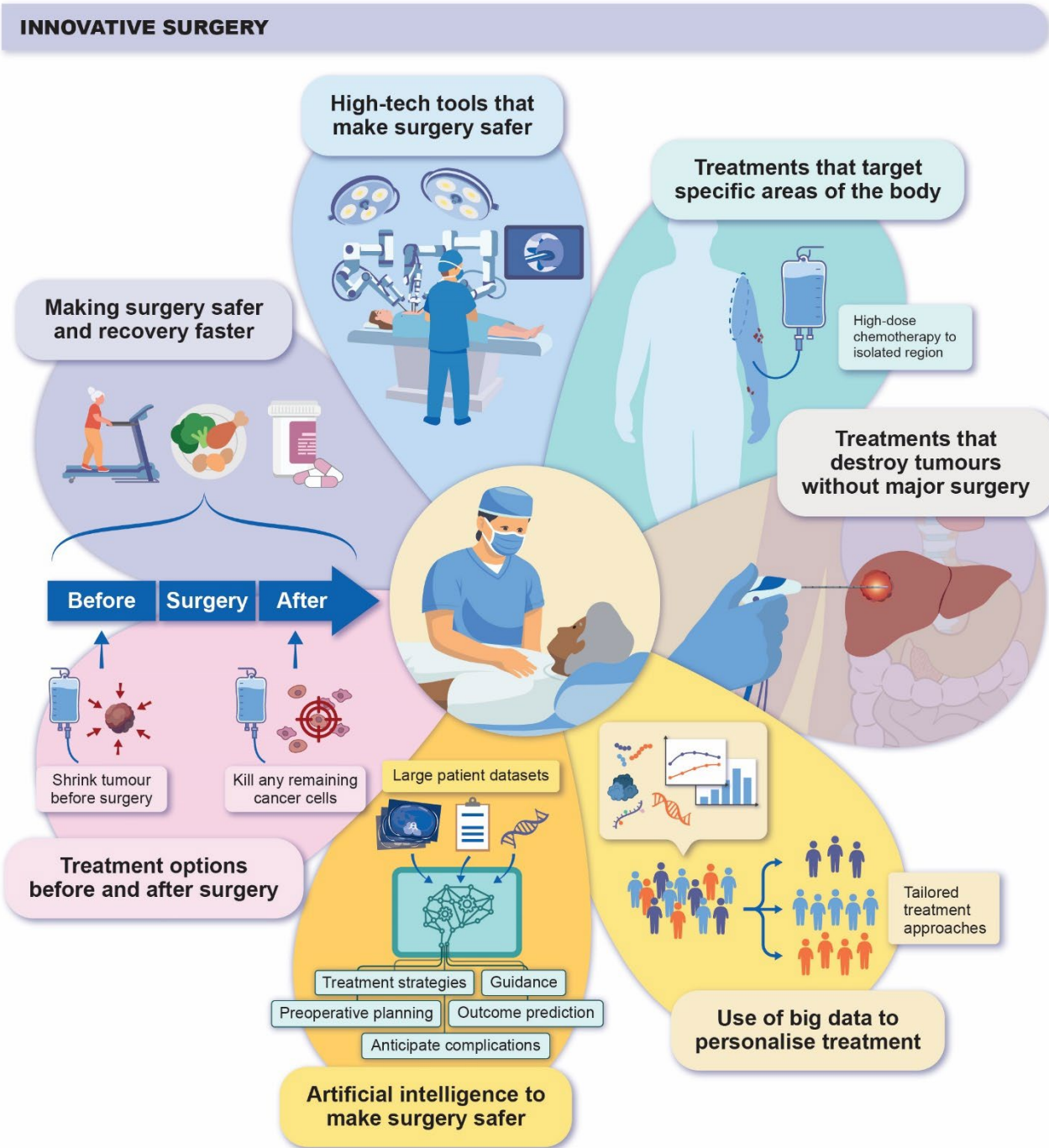
519

520 **Keywords**

521 Innovative surgery; organ-preserving surgery; multimodal cancer treatment; image-guided surgery;
522 regional cancer therapy; ablation; artificial intelligence; precision surgery; ERAS; prehabilitation.

523

524



526

527 **Figure 1:** Surgical treatment may apply to all solid cancers. Surgery is often combined with
528 supplementary procedures like medical treatment, radiation or ablation to increase its efficiency and
529 preserve normal tissue and function. Perioperative physiotherapy and nutrition help patients to
530 tolerate the treatment, and imaging platforms help the surgeon to limit the operation to preserve
531 healthy tissue and organs.

532 **Supplementary S5: Patient information – Physical Methods of Ablation**

533

534 **What is ablation?**

535 Physical ablation of tumours is an image-guided treatment, using heating, freezing, electric pulses
536 or ultrasound to achieve complete tumour destruction, usually in one single treatment. Mechanisms
537 of the different ablative techniques are summarised in table 1.

538 Ablation works across tumour types and can be used when there is one or more tumours that can be
539 safely reached with CT scanning or ultrasound image guidance.

540 Other medical treatments can generally be given alongside tumour ablation.

541

542 **Procedure**

543 Tumour ablation is performed by interventional radiologists, surgeons, oncologists or
544 dermatologists, depending on the location of the tumour and the required ablation technique.

545 Ablation is achieved by inserting one or more thin needles in the tumour (minimally invasive
546 procedure) or using focused ultrasound from outside the body (non-invasive procedure). In either
547 case, some form of anaesthesia is required, either local anaesthesia, conscious sedation or general
548 anaesthesia. Ablation is usually performed at a hospital as an outpatient procedure and is usually
549 performed with a single treatment.

550

551 **Who may benefit?**

552 Ablation is an approved treatment which can be used for both curative and palliative (alleviation of
553 the symptoms) purposes and for various types of cancers. It may be considered when:

- 554 - Only one or more tumours are present, are of suitable size, and it is physically possible to
555 treat them using an ablation technique.
- 556 - Metastatic lesions are causing symptoms such as pain or bleeding, which can be reduced by
557 tumour ablation.

558 Examples of use of ablation:

- 559 - Metastases to the liver: Radiofrequency or microwave ablation, electroporation.
- 560 - Metastases to the skin: Electrochemotherapy.

- Metastases to lymph nodes: Cryotherapy.

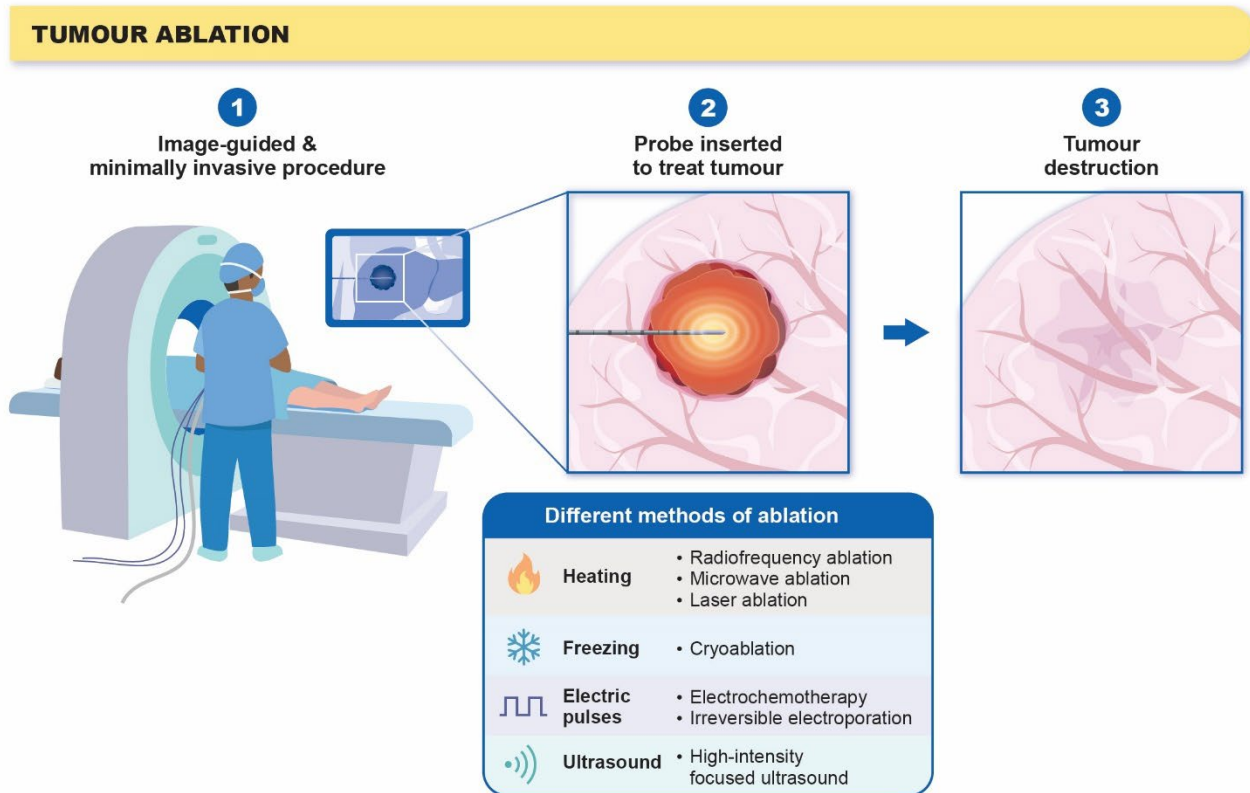


Figure 1: Ablation methods work across cancer types, exemplified here with a liver tumour and microwave ablation. The tumour is first visualised, and a thin needle (probe) is then inserted into the tumour and turned on. Tumour is destroyed, typically with one single treatment.

Success rate

Ablation of tumours is highly effective, with an estimated success rate of 75-95% complete tumour eradication.

Side effects

- Insertion of electrodes:

Pain, transient and restricted to treatment site (common side effect).

Bleeding and infection which is a risk with any invasive procedure (rare side effects)

- Anaesthesia
- Anaesthesia rarely causes complications.
- Other side effects
- Other side effects specific to the individual procedure will be addressed by the treating physician.

Advantages

- Minimally invasive or non-invasive procedure.
- Tumour destruction is typically achieved with just one treatment.
- Local treatment which does not involve major surgical procedures (less complications/side effects compared to surgical resection).
- Quick recovery.
- Admitted and discharged the same day.

How and where to get it

Decisions concerning ablative treatment options are usually made at multidisciplinary team meetings where specialists from e.g. oncology, surgery and radiology meet about patient cases.

Ablation procedures are performed in larger hospitals or specialised cancer centres by highly trained specialists. If your local hospital does not perform tumour ablation, referral to another hospital is possible.

Approved ablative techniques

Ablation technique	How it works
Radiofrequency ablation	A probe is placed in the tumour, and heat is generated using radiofrequency waves. The heat gradually spreads through the tumour and destroys the cancer cells.
Microwave ablation	A heat generating technique similar to radiofrequency ablation but using a probe with microwaves.

High intensity focused ultrasound	Ultrasound waves are directed towards the tumour causing cancer cells to be destroyed by heat. This can be done by placing the ultrasound probe on the skin or placing the probe inside the body (for example in the pee tube near the prostate).
Cryotherapy	In cryotherapy one or more probes are inserted into the tumour. The extreme cold freezes and destroys the cancer cells.
Laser ablation	Laser ablation is a thermal ablation method that works by placing light fibres in the tumour and by heating the tumour.
Irreversible electroporation (IRE)	Electroporation is not a thermal method. It uses short electrical pulses to damage and destroy cancer cells without heat. Electroporation is performed using one or more needles inserted into the tumour.
Electrochemotherapy (ECT)	In electrochemotherapy, electroporation is performed at lower electrical pulse strengths and is combined with a chemotherapeutic agent, making the chemotherapy more effective in the treated area.

Table 1: Ablation techniques and mode of action

Future perspectives

Although several approved methods exist for tumour ablation, research within this field is constantly progressing, and ablation therapies are expected to further improve and expand. This includes both development of ablation probes for larger tumours, new computer-based guidance systems for more accurate insertion of needle(s), and use of radiological imaging to improve the effectiveness.

As medical treatment is also advancing, more patients are likely to benefit from the *combined* effect of medical therapy and ablation. Systematic integration of ablation techniques into clinical guidelines is gradually advancing (2026), raising awareness of tumour ablation options and strategies and support shared decision making within cancer treatment and palliation.

610 **Useful links**

611 Cardiovascular and Interventional Radiological Society of Europe (providing information about
612 ablation and other interventional radiology procedures):

613 <https://www.cirse.org/patients/general-information/ir-procedures/>

614

615 **Keywords**

616 Radiofrequency ablation (RFA), microwave ablation (MWA), high intensity focused ultrasound
617 (HIFU), cryotherapy (Cryo), laser ablation, irreversible electroporation (IRE), electrochemotherapy
618 (ECT), tumour ablation, physical methods of ablation

619

620 **Supplementary S6: Patient information – Cell Therapies**

621

622 Cell therapies are part of what is called *advanced therapy medicinal products (ATMPs)*, a group of
623 innovative treatments that use living cells to treat complex diseases. These cells can be taken from
624 the patients themselves or from a healthy donor. In the lab, they can be modified—or “engineered”
625 when genetically changed—to perform specific therapeutic tasks, such as recognising and
626 destroying diseased cells.

627 A well-known example is *CAR-T cell therapy*, where certain immune cells are engineered to
628 specifically target and attack cancer cells.

629

630 **What is the procedure?**

631 For cell therapies, the cells needed for treatment are collected in a procedure called *leukapheresis*.
632 During this procedure, blood is taken from one arm, the specific cells are separated, and the rest of
633 the blood is immediately returned to the body. This procedure is moderately invasive but well-
634 established, performed by trained professionals, and considered safe, as it has been used for many
635 years in transfusion medicine. In some cases, cells may be collected from bone marrow or through a
636 tissue biopsy.

637 Generally, patients can expect to leave the hospital on the same day, as the collection is typically
638 performed as an *outpatient procedure*.

639 Once collected, the cells are sent to a specialised laboratory where they are grown, modified, or
640 genetically engineered under strictly controlled conditions. This preparation process usually takes
641 about 4-6 weeks before the cells are ready to be re-infused.

642 After thorough quality and safety checks, the modified cells are returned to the patient via a simple
643 infusion, similar to a blood transfusion. The standard treatment plan normally involves one cycle of
644 therapy. Sometimes, a preparatory treatment, such as a short course of medication, is needed to help
645 the modified cells work effectively once they are infused back into the body. These treatments
646 represent an important step toward *precision medicine*, which means personalised care that takes
647 into account each patient’s unique biological and immune characteristics.

648

649 **What are the side effects?**

650 Like all advanced therapies, cell therapies can cause *side effects*. Their severity varies from person
651 to person and depends on the type of therapy, the patients' overall condition, and how their immune
652 system responds. For this reason, patients are monitored closely by highly specialised teams who
653 can quickly recognise and manage any complications.

654

655 *Systemic effects (whole body):*

656 The most common reaction is cytokine release syndrome (CRS). This feels like a severe flu, with
657 fever, fatigue, or low blood pressure. While it can be intense, it is usually transient (temporary),
658 appearing within a few days of the infusion and resolving within a week or two with hospital care.
659 Some patients may also experience neurological effects, such as temporary confusion or difficulty
660 speaking (ICANS). These symptoms are also generally transient and disappear as the body
661 stabilizes. Finally, because the treatment targets certain cells, you might experience a drop in
662 healthy blood cells (Cytopenia), which can last for a few weeks, or a long-term reduction in B-cells
663 (B-cell Aplasia). The latter may persist as long as the therapy is active in your body, but it can be
664 managed with routine medical support.

665

666 *Local effects (site-specific)*

667 If your cells are collected via a tissue biopsy or bone marrow aspiration, you may feel
668 some local soreness, bruising, or discomfort at the site of the procedure. These effects are mild and
669 transient, usually fading completely within a few days. Similarly, the site where the modified cells
670 are infused might show minor redness or swelling, which typically clears up within 24 to 48 hours.

671

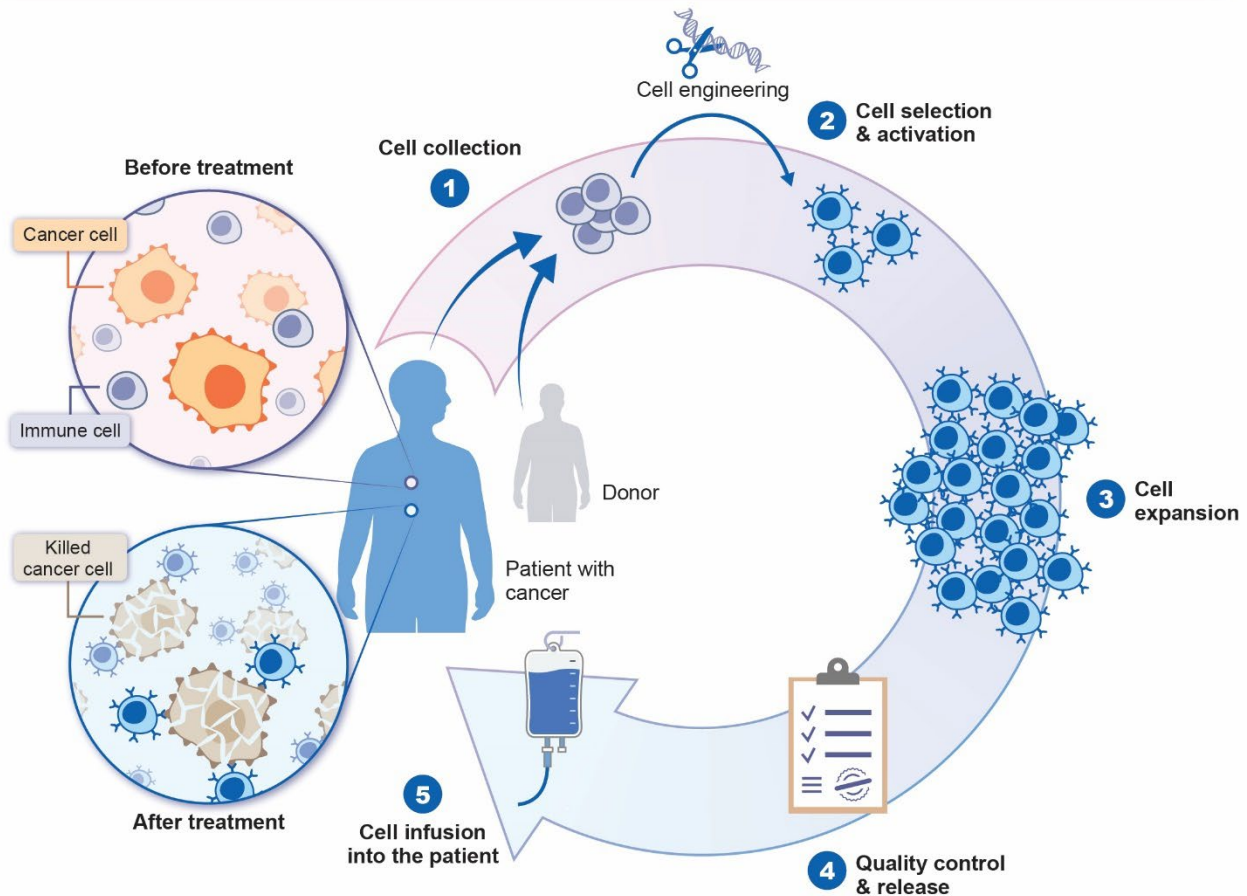
672 *Summary of duration*

673 Most side effects are short-term and occur while you are under close medical supervision. While
674 some immune-related changes can persist longer, your medical team will provide ongoing
675 monitoring to ensure your safety and quality of life throughout the journey.

676

677

CELL THERAPIES



678

679 **Figure 1:** The concept of cell therapies. 1) Cells are collected from healthy donors (allogenic) or
 680 from patient (autologous). 2) Target immune cells are isolated, activated with specific stimuli and in
 681 some cases genetically engineered to enhance their therapeutic function, including CAR insertion.
 682 3) The cells are grown and increased in number in a laboratory before being used for treatment. 4)
 683 The cell product undergoes extensive safety and quality testing. 5) The final product may be infused
 684 to the patient.

685

686 Who performs it and where can I get it?

687 Because of their complexity, cell therapies are administered only in *highly specialised and*
 688 *accredited hospitals*. These centres have the advanced skills and dedicated facilities required for the
 689 treatment. The care process involves several professionals, including:

- 690 - Doctors specialised in advanced therapies, who assess if it is possible to treat, and oversee
691 the treatment journey.
- 692 - Laboratory biologists and technicians, who prepare the cells in controlled and safe
693 environments.
- 694 - Nurses and clinical staff, who assist patients, monitor side effects, and ensure continuous
695 care.

696 Treatment usually takes place in a *hospital setting* and often in a centralised location connected to a
697 network of reference centres that refer patients and share common protocols. Not all oncology or
698 haematology centres can administer these therapies, so collaboration between facilities is essential.
699 In some cases, treatment may be carried out abroad, although cross-border access can be
700 complicated due to different rules regarding reimbursement, authorisation, and follow-up. For more
701 information about treatment and referral options, you should contact your treating physician.

702

703 **Who may benefit?**

704 Cell therapies are already approved for several *blood cancers*, such as leukaemia, lymphoma, and
705 multiple myeloma, as well as for some *solid tumours* like melanoma and synovial sarcoma. For
706 many other cancers - breast, lung, prostate, gastrointestinal, head and neck, urogenital - research is
707 still ongoing, with clinical trials assessing safety and effectiveness. In the future, these therapies
708 may also be used outside oncology, for certain *autoimmune diseases*, and will likely become
709 available for an increasing number of cancers as research progresses.

710

711 **What are the future perspectives?**

712 The goal of new cell therapies is to be more *effective, safer, easier to administer, and accessible* to
713 more patients. At the European level, initiatives are underway to improve regulation, access, and
714 patient information, including the creation of official lists of accredited treatment centres. Some
715 therapies that are currently experimental may become part of *standard clinical practice*, offering
716 new options to patients who currently have limited alternatives.

717

718 **Glossary**

719 *ATMP – Advanced Therapy Medicinal Products*

720 European category that includes advanced therapies based on cells, genes, or tissues. These
721 treatments are highly innovative and strictly regulated.

722 *CAR-T*

723 Short for *Chimeric Antigen Receptor T cells*. These are immune cells from the patient that are
724 modified in the laboratory to recognise and attack cancer cells.

725 The engineering process involves adding a gene called the Chimeric Antigen Receptor (CAR) to T
726 cells. This new gene helps the T cells detect and fight tumour cells. In other words, CAR-T cells are
727 specially designed to find and attack cancer cells in a targeted way.

728 *Precision Medicine*

729 An approach that tailors treatment to the specific characteristics of each patient (genetic, biological,
730 or immunological).

731 *Tissue Biopsy*

732 A procedure in which a doctor removes a small sample of tissue from the body. This can be done
733 with a needle, a small surgical instrument, or under imaging guidance like ultrasound or CT.

734 *Leukapheresis*

735 (A combination of Greek words meaning “white” and “to remove”) – a process that removes white
736 blood cells (leukocytes) from the blood.

737 *Autoimmune Diseases*

738 Chronic conditions in which the immune system mistakenly attacks healthy tissues, caused by a
739 combination of genetic and environmental factors.

740

741 **Useful links**

742 The European Medicines Agency (for simple explanation of what advanced therapies (like gene and
743 cell therapies) are and how they are checked for safety, quality, and effectiveness in the EU:

744 [https://www.ema.europa.eu/en/human-regulatory-overview/advanced-therapy-medicinal-products-](https://www.ema.europa.eu/en/human-regulatory-overview/advanced-therapy-medicinal-products-overview)
745 [overview](https://www.ema.europa.eu/en/human-regulatory-overview/advanced-therapy-medicinal-products-overview)

746 The Spanish Agency for Medicines and Health Products (information about cell therapies):
747 [https://www.aemps.gob.es/medicamentos-de-uso-humano/medicamentos-biologicos/terapias-](https://www.aemps.gob.es/medicamentos-de-uso-humano/medicamentos-biologicos/terapias-avanzadas/)
748 [avanzadas/](https://www.aemps.gob.es/medicamentos-de-uso-humano/medicamentos-biologicos/terapias-avanzadas/)

749

750 **Supplementary S7: Patient information – Ex-vivo Testing of Agents**

751

752 **Why test cancer cells outside the body?**

753 Cancer treatments are often chosen using standard guidelines and genetic tests. While this works for
754 many people, it does not always show which treatment will be most effective for an individual
755 patient. Cancers that seem similar can have significant differences, resulting in very different
756 responses to treatments. *Ex-vivo* testing offers a complementary approach. It allows researchers and
757 clinicians to study how a patient's own cancer cells respond to different treatments/drugs *outside the*
758 *body*, in a laboratory. This helps move cancer care toward more personalised treatment decisions.

759

760 **What is ex-vivo testing?**

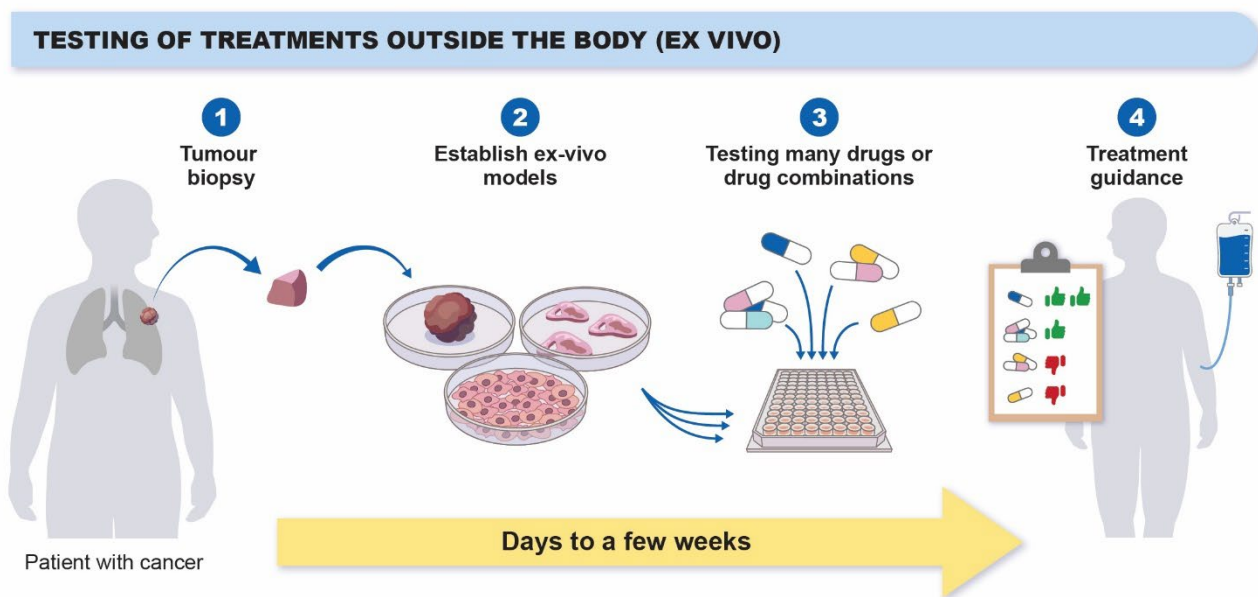
761 Today, biopsies are already part of routine cancer care, mainly used to *diagnose the cancer* and to
762 analyse its *genetic characteristics*. With *ex-vivo* testing, the procedure to collect the sample is
763 usually the same or very similar and it can also be obtained during surgical tumour removal.
764 Researchers take a small portion of the patient's tumour and keep the cancer cells alive in the
765 laboratory. These cells are then exposed to different treatments, allowing scientists to observe and
766 study which therapies are most effective for that individual tumour.

767

768 **How can ex-vivo testing help guide cancer treatment?**

769 The main goal of *ex-vivo* testing is to *support more personalised treatment*, moving away from a
770 “one-size-fits-all” approach and toward treatments that are more closely adapted to each individual
771 patient. Traditional cancer treatments-such as surgery, chemotherapy, radiotherapy, and hormonal
772 therapy- do not always fully account for differences between patients or the complexity and
773 variability of individual tumour. Thus, *ex-vivo* testing looks at *how your own cancer cells respond*
774 *to different drugs*. By observing which treatments seem effective — and which do not — doctors
775 and researchers hope to better *guide treatment choices*, especially when several options are possible.
776 The long-term aim is to save time and increase efficiency by avoiding useless therapies.

777



778

779 **Figure 1:** An overview of ex-vivo drug testing and how it may be integrated into clinical care. A
 780 patient's tumour sample is collected at diagnosis and/or at relapse as part of routine clinical
 781 procedures. Tumour cells are then processed in the laboratory using an ex-vivo drug sensitivity
 782 screening platform. Multiple drugs are tested in parallel, which makes it possible to evaluate
 783 potential treatments. The results are then discussed by a multidisciplinary molecular tumour board,
 784 often together with genomic profiling data, to help inform individualised treatment decisions.

785

786 **Is ex-vivo testing already part of routine cancer care? How does the process work?**

787 At the moment, *ex-vivo* testing is *not yet part of routine clinical care*. It is still conducted within
 788 *research settings* and clinical studies. This means the methods are evolving and being carefully
 789 evaluated. After the tumour sample is collected, it is sent to a laboratory. There, the cancer cells are
 790 *processed and grown under controlled conditions*. Testing drugs on living cells also requires days or
 791 weeks of careful work.

792

793 **What types of ex-vivo technologies are currently being studied?**

794 Several *ex-vivo* technologies are being evaluated today. All of them aim to study how cancer cells
 795 respond to treatment outside the body, but they do so in different ways:

- 796 - *Patient-derived cancer cell lines*: Tumour cells grown in flat (2D) cultures.
- 797 - *tumour explants/tumour tissue slices*: Thin sections of fresh tumour tissue kept alive for
- 798 short-term testing.
- 799 - *Patient-derived organoids/ assembloids*: Three-dimensional “mini-tumours” grown in the
- 800 laboratory. When other cells, e.g. tumour microenvironment cells, are added to organoids,
- 801 another form of advanced "mini-tumour" is developed, called assembloid.
- 802 - *Patient-derived xenografts (PDX)*: Tumour tissue implanted into mice to preserve tumour
- 803 complexity.
- 804 - *Tumour-on-chip systems*: Micro-devices that recreate key aspects of the tumour
- 805 environment.

806 Some technologies may prove more useful than others, and new approaches may be developed in

807 the future as science progresses.

808

809 **What benefits could it bring to patients?**

810 If successfully integrated into care, *ex-vivo* testing could bring several important benefits: *More*

811 *personalised treatments*, better adapted to each patient’s tumour; *Alternative therapeutic options*,

812 especially in complex situations or when standard treatments no longer work; *Drug repositioning*,

813 meaning existing medicines could be identified as useful for a different cancer than originally

814 intended

815 By identifying treatments that are unlikely to work, this approach may also help *avoid wasting time*

816 *on inappropriate treatments, with all their drawbacks* and focus on options with a higher chance of

817 benefit.

818

819 **What are the limitations of ex-vivo testing?**

820 Since *ex-vivo* testing is still in the research phase, there is an important *element of uncertainty*.

821 Sometimes cancer cells cannot be grown successfully in the laboratory, or the results may not fully

822 reflect what happens in the patient’s body. There are also scientific challenges, such as reproducing

823 the complexity of the immune system or maintaining stable cell cultures over time. For these

824 reasons, *ex-vivo* testing can sometimes *fail or provide false positive, negative or inconclusive*
825 *results*, and it cannot yet replace standard clinical decision-making. However, compared with other
826 out-of-body model systems currently available, *ex-vivo* approaches more closely reflect the
827 patient's own tumour biology. *Ex-vivo* testing is not infallible-but neither are current standards of
828 care. In fact, the limitations of existing treatments are precisely what have driven the development
829 of *ex-vivo* systems. Being transparent about these limits is essential so that patients understand both
830 the *promise and the current boundaries* of this approach.

831

832 **Keywords:** Functional precision oncology; Patient-derived cells; Patient-derived organoids; Tumour
833 tissue slices; Tumour-on-chip systems; Drug Screening

834

835 **Useful links:**

836 *Short educational videos:*

837 Understanding *ex-vivo* testing and personalised cancer treatment:

838 https://www.youtube.com/watch?v=E_GpS410OpQ

839 Functional precision oncology; how treatments are tested on tumour cells:

840 <https://www.youtube.com/watch?v=ydHmkxZ2jIQ>

841 How cancer cells are tested outside the body:

842 <https://www.youtube.com/watch?v=vY9Ij5uZTgc>

843 Personalised approaches in cancer care:

844 https://www.youtube.com/watch?v=lBIFwuEQW_E

845 What is a PDX mouse model?:

846 https://www.youtube.com/watch?v=nYbR7BHY_Dw

847 2D and 3D cancer models and organoids; Organoid technologies in research:

848 <https://www.youtube.com/watch?v=vywZVtDyj9E>

849

850 *Further sources of information:*

851 Wikipedia (functional drug sensitivity testing, general overview):
852 https://en.wikipedia.org/wiki/Functional_drug_sensitivity_testing
853 Scientific publication “Precision oncology using ex vivo technology: a step towards individualised
854 cancer care?”:
855 <https://pmc.ncbi.nlm.nih.gov/articles/PMC9884776/>
856 Mayo Clinic (example of an ex-vivo research study):
857 [https://www.mayo.edu/research/centers-programs/center-individualized-medicine/research/clinical-](https://www.mayo.edu/research/centers-programs/center-individualized-medicine/research/clinical-studies/ex-vivo)
858 [studies/ex-vivo](https://www.mayo.edu/research/centers-programs/center-individualized-medicine/research/clinical-studies/ex-vivo)
859 Review “Ex vivo drug screening: an emerging paradigm in the treatment of childhood cancer”
860 (provides information about ex vivo drug screening and how it can be performed):
861 https://eprints.whiterose.ac.uk/id/eprint/225452/8/Ex_vivo_drug_screening_pediatric_v1.4_DK.pdf
862