Brachytherapy

Patterns of care for brachytherapy in Europe: Updated results

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Abstract

Objective: This descriptive survey evaluated brachytherapy (BT) practices and resources in the European area. This was a follow-up study to the original patterns of care for brachytherapy in Europe (PCBE). Materials and methods: A total of 1121 radiotherapy (RT) centres from 41 countries were asked to complete an online questionnaire on BT practices and resources. Countries with fewer than 50% of centres responding were excluded. Participating countries were divided into three groups based on gross domestic product (GDP); group I contained the countries with the highest GDP. Results: The response rate was 56% (633/1121 centres) with 30/41 countries (73%) meeting the inclusion criteria. Sixty percent of reporting centres provided brachytherapy. Responding centres treated an average of 138 (±10, 1 SD) patients with BT; in group I, the mean was 110/centre, an increase of 18% from 2002. CT-dosimetry increased to 61% of centres vs. 33% in 2002. HDR (high-dose rate) BT was the most commonly reported technique (65% of centres). Most BT interventions were for gynaecological tumors (59% of all cases), followed by prostate (17%), breast (9%), lung/bronchus (3%), and esophagus tumors (2%). Conclusion: Gynaecological BT remains the most common application, although both prostate and breast BT have increased. CT-based dosimetry has become increasingly common since 2002. The use of HDR and PDR (pulsed-dose rate) techniques has increased markedly, while both LDR and MDR (medium-dose rate) have declined.

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In the last two decades, the development of new technologies has led to important advances in radiation oncology. New techniques in external beam therapy, such as intensity-modulated radiotherapy, image-guided radiotherapy, and proton therapy, have made it possible to deliver highly conformal doses of ionizing radiation directly to the tumor [1,2]. Similarly, brachytherapy (BT) technology continues to be refined and improved. BT is used either as a primary treatment (e.g., in prostate and gynaecological tumors) or as a boost following surgery or external beam radiotherapy [3]. The clinical practice of BT, however, is not uniform, and there are regional and country-specific variations.

To keep abreast of developments in BT and regional differences in clinical practice, in the year 2001 the Groupe Européen de Curiethérapie European Society for Therapeutic Radiology and Oncology (GEC-ESTRO) decided to undertake a pattern of care study for brachytherapy in Europe (PCBE) [3] to document patterns of clinical practice and to evaluate the BT-related resources utilized in European radiotherapy (RT) centres in the year 2002. These data were analysed and published in numerous papers [4–11]. The present follow-up study, expanded to include radiotherapy centres in Latin America, was launched in 2008 to collect data for calendar year 2007. The name of the original PCBE study was changed to PCB (patterns of care for brachytherapy) to reflect the new geographical scope of the study.

The objective was to create a detailed information system on brachytherapy practices and resources throughout the European Union and to monitor changes over time. In the present paper, we report the European results for 2007 and compare these to the previously reported 2002 findings. Results for Latin America will be reported separately.

Material and methods

This was a descriptive pattern of care survey developed by the GEC-ESTRO and conducted via an online questionnaire. The web
site is no longer accessible, but the questionnaire can be viewed in the online version of this paper (Appendix A). The methods have been described previously [5], but to summarize, a total of 1121 radiotherapy centres located in 41 countries in and proximate to Europe were identified and a web-based questionnaire was made available for participating centres.

A national coordinator was appointed for each country to (a) provide an updated list of RT centres in that country, (b) make the existence of the survey known, (c) contact centres directly to encourage participation, and (d) coordinate with the general coordinator.

The survey contained items on a wide array of brachytherapy practices. The 2002 and 2007 questionnaires were similar but not identical as changes were made to address limitations observed in the first survey: some questions were made more specific, a few were discarded, and several new ones were added—in most cases to gather more detailed information on clinical approaches to the most common tumor sites: gynaecology, prostate, breast, and lung.

For the analysis, we followed the precedent set by the ESTRO QUARTS study [12,13] as well as the original PCBE survey [5]. Countries in the European area were divided into three groups based on gross domestic product (GDP) per capita (high, medium, and low resource countries). In the present study we were unable to confirm the participation of three countries (Luxembourg, Monaco, and Ukraine) included in the 2002 study and so they are not included in the 2007 data. In the original study, the first group (called “EC + 4”) included the high resource countries of Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Monaco, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, and the United Kingdom (UK). In the present study, this group (now called “group I”) consisted of 17 countries (all those listed above except Luxembourg and Monaco). The second group, now called Group II (previously denominated “New European Countries”), contained the same 10 countries as in the original PCBE study: Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia, and Slovenia. Group III (originally called “Other European Countries”) consisted of the same countries as in 2002 except that Montenegro was added and Ukraine removed; group III contained the following 14 countries: Albania, Armenia, Belarus, Bosnia and Herzegovina, Bulgaria, Croatia, Georgia, Israel, Macedonia, Moldova, Montenegro, Romania, Serbia, and Turkey.

For the present report, we provide results of the 2007 data for all 3 groups. Comparative results for the PCBE (i.e., 2002) vs. the PCB (2007) are given only for group I because reliable comparisons cannot be made for groups II and III due to the low response rates obtained in 2002 in those two groups (18% and 8% of RT centres, respectively). When appropriate, between-group comparisons are presented.

Statistical analysis and inclusion criteria

Only those countries that obtained responses from at least 50% of RT centres were included in the final analysis. This is a descriptive report and percentages were used to describe the categorical variables and means ± standard deviation (SD) were used for continuous variables. Statistical analysis was performed with the Statistical Package for the Social Sciences, version 13.0 (SPSS Inc., Chicago, Illinois, USA).

Results

Of the 1121 registered RT centres located in the 41 countries that agreed to participate, 633 (56%) completed the survey; by group, participation rates were 54% (group I), 78% (group II), and 55% (group III). Of the 633 responding centres, 382 (60%) provided brachytherapy: group I (294/491 centres = 60%); group II (54/70 = 77%), and group III (34/72 = 47%).

Response rates and inclusion/exclusion of countries

Thirty of the 41 (73%) European-area countries that participated in the study fulfilled the inclusion criteria. The following 11 countries were excluded for failing to meet the inclusion criteria: Germany, Greece, and Ireland (group I); Estonia, Latvia, Malta, and Slovenia (group II); Armenia, Belarus, Croatia, and Turkey (group III). Response rates from the 5 largest countries (ranked by number of RT centres) were as follows: Germany (21/225 centres; 9% excluded); France (102/183; 56%); Italy (134/142; 94%); Spain (70) 95; 74%); and the UK (40/61; 66%). In all 5 cases, participation was lower than in the first PCBE study, although participation in most of the included countries was strong, with 22 of the 30 included countries having achieved a response rate of 90% or greater. All data provided from this point forward refer only to RT centres located in countries that met the inclusion criteria, unless otherwise specified. The analysis is therefore based on 14 countries in group I, 6 in group II, and 10 in group III. All comparisons between 2002 and 2007 data are given only for group I.

Number of patients per centre

Overall, European RT centres treated an average of 1325 (±45, 1 SD) pts/centre in 2007; by group, the means were as follows: group I, 1287 (±48, 1 SD); group II, 1590 (±168, 1 SD); and group III, 1300 (±165, 1 SD). Fig. 1 shows the mean number of BT pts/centre by year and by group. Averaged over all centres, 138 (±10, 1 SD) pts/centre were treated with brachytherapy in 2007; by group (I, II, and III, respectively), the means were 110 (± 7, 1 SD), 221 (±36, 1 SD), and 272 (±76, 1 SD). For comparison, the group I mean in 2002 for BT was 93 pts/centre.

Facilities and equipment

The overall mean number of shielded rooms/centre was 2.2 (±0.1, 1 SD). The percentage of centres with a dedicated BT operating room (63% in group I vs. 48% in 2002) is shown in Table 1, as is the proportion of centres that reported using the following dosimetric techniques: plain film X-rays, computed tomography (CT), ultrasound, magnetic resonance imaging (MRI), positron-emission tomography (PET)-CT, and in vivo dosimetry. MRI-dosimetry increased to 16% of group I centres (vs. 5% in 2002) while CT-dosimetry was reported by 61% of centres (vs. 33% in 2002).

![Figure 1. Mean number of patients treated by BT per centre, by group and year.](image-url)
Most centres (59%) had a single afterloading unit, while 19% of centres reported 2 units, 13% had none, 7% had 3 units, and 2% reported 4 afterloaders. The most common type of unit was a high-dose rate (HDR) afterloader (63%), followed by pulsed-dose rate (PDR; 17%), low-dose rate (LDR; 15%), combined LDR/MDR (medium-dose rate) (3%), MDR (2%), and combined PDR/HDR afterloader (1%).

**Type of brachytherapy used**

Table 2 shows the total number of pts and dose rates for the three most common tumor sites. In group I, a mean of 59 pts/centre was treated for gynaecological tumors, 54 for prostate, and 38 for breast. Overall, HDR was the most commonly used technique, with 65% of centres reporting its use. After HDR, the second most common technique was very-low-dose rate (VLDR) (13% of centres), followed by LDR (10%). HDR was the most common technique in all groups for breast (58% of interventions) and gynaecological (78%) tumors. Fig. 2 shows the dose rate techniques used in all groups for breast (58% of interventions) and gynaecological (48%), prostate (26%), and lung/breast (3%). Combined LDR/MDR (medium-dose rate) (3%), MDR (2%), and combined PDR/HDR afterloader (1%) were not considered in the respective questionnaires.

**Anatomical sites**

The most common tumors treated by BT in all groups were, in descending order of frequency: gynaecological (59%), prostate (17%), breast (9%), lung/bronchus (3%), and esophagus (2%). In group I, the five most common tumor sites were as follows: gynaecological (48%), prostate (26%), breast (12%), eye (3%), and esophagus (2%). Endometrial BT was the most common treatment overall (31% of all cases) and within each group, accounting for 29%, 38%, and 33% of cases, respectively, in groups I, II, and III. The second most common site was the cervix (25% of cases); this localization accounted for 15% of cases in group I, 31% in group II, and 57% in group III. Fig. 3 shows the most common anatomical sites treated in 2002 and 2007 for group I. The top 3 sites remained unchanged from 2002, although interventions for eye and oesophageal cancer surpassed those for lung and head & neck cancer.

Treatment intent (preoperative, postoperative, or definitive) for gynaecological tumors in group I was as follows: endometrium (1.5%, 90.6%, and 7.9%, respectively); cervix (13.5%, 31.4%, 55.1%); vagina (2.8%, 51.9%, 45.3%); and vulva (5.6%, 27.8%, and 66.7%). Of the 95 centres in group I that responded to survey questions regarding adherence to the GEC-ESTRO guidelines for gynaecological tumors [14,15], 57 (60%) confirmed guideline observance.

Overall, breast brachytherapy accounted for 9% of all patients treated by BT (12% in group I, 5.4% in group II, and 0.6% in group III). HDR was the preferred BT technique for breast tumors in 58% of centres, followed by PDR (19%) and LDR (3%). Of centres that reported using breast BT as a boost, 95% use a multicatheter technique, 2% a balloon technique, 2% intra-operative BT, and 1% "other".

Iodine-125 (125-I) seeds were the most commonly reported technique for prostate treatments overall (in use at 73% of centres), followed by iridium-192 (192-Ir) HDR (18% of centres), and 192-Ir LDR (8%). In group I, the 125-I was the most common technique (79%), followed by 192-Ir HDR (13%), 192-Ir LDR (7%), and "other" seeds (palladium-103; 1%). Of the centres that responded to questions on type of planning used, 36/94 centres (38%) reported utilizing pre-planning for seed implants, 67/91 (74%) intra-operative planning, 56/80 (70%) intra-operative pre-planning, and 80/91 (88%) interactive planning. Of the 123 centres in group I that reported using seeds, 52 (42%) used strands only, 47 (38%) loose seeds only, and 24 (20%) both.

**Workloads and staffing levels**

Overall, centres reported a mean of 6.3 radiation oncologists per centre. By group (I, II, III), the respective means were 6 (±0.2, 1 SD) (vs. 6.4 in 2002), 8.6 (±1.0, 1 SD), and 5.7 (±0.9, 1 SD). The mean number of trainees per centre was 3. The average number of these specialists that performed brachytherapy procedures in group I was 3.0 (vs. 2.9 in 2002).

**Type of cancer centre**

Of the RT centres that responded to this question (more than one answer was possible), most were public centres (47%), followed by specialized cancer centres (26%), academic (25%), and private (20%). In group I, of the 496 RT responding centres, 238 (48%) have reported to be public, 114 (23%) private, 115 (23%) academic, and 100 (20%) specialized cancer centres.

**Discussion**

**Response rate**

Approximately 3 out of 4 countries met the inclusion criteria and 56% of all surveyed centres responded to the questionnaire (vs. 69% in 2002). Most of this decrease was attributable to the 20% point decline in participation in group I. The large increase in groups II (from 18% to 78%) and III (from 8% to 55%) helped to partially offset these losses, but because the vast majority of RT centres are located in group I countries, the decreased participation in that region led to a lower overall response. The low response in some large countries had a large negative impact. For instance, in 2002, responses were obtained from nearly 1 out of 4 RT centres in Germany, but only 1 out of 10 in the present study. In both the UK and Italy, response rates were similar to those obtained in 2002, but participation decreased notably in both France (from 76% to 54%) and Spain (from 97% to 74%). Several countries that were included in 2002 failed to meet the cut-off level in 2007, most notably Ireland in group I.
There are undoubtedly numerous factors that contributed to the decreased participation. Firstly, enthusiasm for the study may have diminished compared to the original 2002 study, which was the first of its kind in Europe. Secondly, several centres reported difficulties with the web page and we suspect that these technical problems negatively impacted response rates, although we cannot quantify the extent of this effect. Another factor may have been the length of the questionnaire, which was more detailed than the 2002 version. Some private centres may have been reluctant, presumably for competitive reasons, to release proprietary data; only 20% (23% in group I) of participating centres were private institutions. These impediments notwithstanding, nearly 3 out of 4 participating countries achieved response rates over 90%. Especially promising was the increased participation observed in groups II and III. Nevertheless, issues affecting participation must be addressed in any future PCB study.

Number of cases treated by RT or BT

Despite the economic differences between countries in group I and those in group III, the average number of RT pts/centre was virtually identical (approximately 1300). In contrast, group II had a much higher mean (1600). The reason for this divergence is not clear. However, groups II and III showed more similarities in terms of the number of BT patients/centre, and the average number of BT patients per centre in both groups was double that of group I. We hypothesize that BT is more centralized in these less affluent countries compared to the wealthier countries of group I, mainly because establishing a new BT treatment unit involves considerable expenses not easily obtainable in countries with limited resources; logically, it makes sound economic sense to build and maintain fewer centres in such cases. Also, it is known that some group I countries have policies designed to centralize BT/RT services—for instance, Denmark [16] and the UK [6,17], but this is certainly not the case for all countries in this group. Spain, for instance, has no established policy in this regard [6]. It should be noted that, while specialization of cancer care offers many prospective benefits—including reduced costs and increased physician expertise—it is not without potential disadvantages, including increased waiting times, reduced access to care for deprived patients, and an imbalance between capacity and demand—as a recent report points out [18].

Slightly more than a third (34%) of European RT centres confirmed that they offer brachytherapy. This is lower than the 42% reported in 2002 [5]. However, these percentages may be misleading as they include all centres in the survey, even those that failed to respond. Excluding non-responding centres, 60% (382/633) of participating centres offered BT, virtually the same as in 2002 (61%). The difficulty in interpreting these data, however, is that we cannot know if centres that failed to respond offer brachytherapy or not. Our data shows, however, that the average number of BT pts/centre has increased over time, perhaps due to government efforts to create specialized, large-volume RT services.

Case load by group and localization

The total number of pts in group I treated for gynaecological, prostate, and breast cancer increased from 2002 to 2007. The overall numbers are presented in the results section. Compared to 2002, increases were observed at all three major tumor sites: gynaecological cases increased to 59 pts/centre vs. 55 in 2002 (a 7% increase); prostate, 54 pts/centre vs. 41 (a 29% increase); and breast, 38 pts/centre vs. 27 (a 41% increase). We discuss the reasons for these changes in more detail below, but briefly the factors likely include (a) increased incidence rates for all 3 of these tumors, (b) new indications for BT treatments at these sites (made possible in part by new technologies, such as image-guided BT, accelerated partial breast irradiation (APBI), and real-time treatments), and (c)
recommendations from professional societies such as the GEC-ESTRO. While no definitive conclusions can be made, our data seem to point to an increasing use of BT to treat these cancers. In some countries, centralization of BT therapy may explain part of the observed increase.

**Dedicated operating room**

A marked increase in the percentage of centres with a dedicated BT operating room was observed in group I, and nearly 2 out of 3 centres (compared to less than half in 2002) now provide a dedicated room. Indeed, most centres in all groups reported the availability of a dedicated operating theatre. The large increase from 2002 to 2007 in group I would seem to suggest a growing recognition of the requirements for BT within institutions. The benefits of a dedicated room are clear, as the entire brachytherapy treatment can be carried out in a single session: implantation, implant reconstruction, dose planning and delivery [19]. Especially important is that patient transfer is minimized, thereby reducing the risk of organ movement.

**Dosimetry**

The use of CT-based dosimetry increased substantially in group I (from 33% of centres in 2002 to 61% in 2007). For comparison, only 26% and 48% of centres in groups II and III, respectively, offered CT-dosimetry in 2007. This is logical and not unexpected given the more limited resources in these countries. CT-based dosimetry has become increasingly available since its development in the early 1990s, undoubtable because it is relatively inexpensive and provides far more details of implant quality than conventional X-rays [20–22]. Our data show that centres are making the transition from conventional radiographs to CT-based dosimetry, though the conversion is not complete yet. Even with the notable growth of CT-dosimetry, other dosimetric modalities, such as ultrasound, MRI and PET-CT, are also becoming increasingly common.

MRI-based dosimetry in group I accounted for 16% of BT procedures in 2007 vs. only 5% in 2002. Given that the GEC-ESTRO began recommending MRI-dosimetry for gynaecological BT in 2005, this finding was not anticipated [14,15,23]. Furthermore, we have found that 60% of centres reported adhering to these recommendations. While the benefits of MRI-dosimetry in prostate cancer have also been described, it has not yet become a standard practice, although this may occur in time given the improved visualization of tumor extension and areas with high metabolic activity that techniques such as spectroscopic MRI provide [24,25].

Relatively few centres (5% in group I) use PET-CT for dosimetry, perhaps because of limited evidence to support its use at present and the technological challenges involved. However, because of the ability of PET-CT to detect areas of tumor invasion not seen on conventional CT scans [26], if additional evidence supports its use, PET-CT for dosimetry is likely to increase, especially in high resource countries.

**Prostate BT**

Prostate BT is performed much more frequently in group I countries than in groups II or III (Table 2). This divergence can be explained by differences in incidence rates. In 2006, the estimated age-standardized incidence rate (ASR) per 100,000 population for prostate cancer in the European Union (EU)-25 (i.e., group I countries) was 106.2 vs. 86.7 for Europe as a whole—a grouping that includes the EU countries plus many of the group II/III countries, such as the Czech Republic, Serbia, Croatia, Bulgaria, Romania, and others [27]. In group I, this site accounted for more than a quarter of all interventions in 2007 vs. only 14% in 2002. This large increase is probably partially related to the rising incidence rate for this tumor localization, which in turn is associated with the increased use of PSA testing and greater awareness of the disease in these countries [28]. This is supported by the epidemiological data, which shows that the ASR in Western Europe increased from 61.6 in 2002 [29] to 106.2 in 2006 [27]. Increased detection, as evidenced by the rising incidence rate, logically implies an increase in the number of early-stage cancers amenable to treatment with BT. Aside from the rising incidence of prostate cancer, other factors may be involved, although these are not quantifiable from the survey data: economic growth during the 2002–2007 period and an increasing willingness of governments and insurance companies to pay for seeds. In addition, evidence from longer term studies of BT is accumulating and results to date support the use of prostate BT, particularly in selected cases (dependent mostly on stage and patient age). Seed BT, for example, is comparable to surgery in terms of biochemical control but with fewer side-effects, and physicians may be increasingly disposed to recommend this technique as a primary treatment in low-risk cancer, or as a boost (seeds or HDR) after external beam RT in intermediate or high-risk cases [5,30–33]. Our data show that seed BT with 125-I is the most common technique for prostate cancer (73%). HDR is also common.

Table 2

<table>
<thead>
<tr>
<th>Cytology</th>
<th>No. patients</th>
<th>No. centres</th>
<th>LDR</th>
<th>MDR</th>
<th>HDR</th>
<th>PDR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gynaecology</td>
<td>Overall</td>
<td>27,020</td>
<td>297</td>
<td>3323 (12.3%)</td>
<td>816 (3.0%)</td>
<td>21,097 (78.1%)</td>
</tr>
<tr>
<td>Group I</td>
<td>13,222</td>
<td>225</td>
<td>2069 (15.7%)</td>
<td>442 (3.3%)</td>
<td>9292 (70.3%)</td>
<td>1419 (10.7%)</td>
</tr>
<tr>
<td>Group II</td>
<td>4086</td>
<td>53</td>
<td>821 (10.2%)</td>
<td>145 (1.8%)</td>
<td>6981 (86.3%)</td>
<td>139 (1.7%)</td>
</tr>
<tr>
<td>Group II</td>
<td>5125</td>
<td>19</td>
<td>66 (1.3%)</td>
<td>235 (4.6%)</td>
<td>4824 (94.1%)</td>
<td>0 (-)</td>
</tr>
<tr>
<td>Prostate</td>
<td>Overall</td>
<td>7940</td>
<td>806</td>
<td>5890 (74.2%)</td>
<td>223 (2.8%)</td>
<td>45 (0.6%)</td>
</tr>
<tr>
<td>Group I</td>
<td>7224</td>
<td>133</td>
<td>5808 (80.4%)</td>
<td>192 (2.7%)</td>
<td>45 (0.6%)</td>
<td>1179 (16.3%)</td>
</tr>
<tr>
<td>Group II</td>
<td>672</td>
<td>672</td>
<td>38 (5.7%)</td>
<td>31 (4.6%)</td>
<td>0 (-)</td>
<td>603 (89.7%)</td>
</tr>
<tr>
<td>Group III</td>
<td>44</td>
<td>1</td>
<td>44 (100%)</td>
<td>0 (-)</td>
<td>0 (-)</td>
<td>0 (-)</td>
</tr>
<tr>
<td>Breast</td>
<td>Overall</td>
<td>3918</td>
<td>113</td>
<td>119 (3.0%)</td>
<td>2281 (58.2%)</td>
<td>723 (18.5%)</td>
</tr>
<tr>
<td>Group I</td>
<td>3233</td>
<td>84</td>
<td>111 (3.4%)</td>
<td>1704 (52.7%)</td>
<td>639 (19.8%)</td>
<td>779 (24.1%)</td>
</tr>
<tr>
<td>Group II</td>
<td>652</td>
<td>26</td>
<td>8 (1.2%)</td>
<td>560 (85.9%)</td>
<td>84 (12.9%)</td>
<td>0 (-)</td>
</tr>
<tr>
<td>Group III</td>
<td>33</td>
<td>3</td>
<td>0 (-)</td>
<td>17 (51.3%)</td>
<td>0 (-)</td>
<td>16 (48.5%)</td>
</tr>
</tbody>
</table>

Abbreviations: LDR, low-dose rate; MDR, medium-dose rate; HDR, high-dose rate; and PDR, pulsed-dose rate.
(nearly 1 in 5 treatments), though nearly always as a boost rather than as a primary treatment.

Gynaecological BT

Although the absolute number of gynaecological interventions rose with respect to 2002, gynaecological cases actually decreased relative to other sites, especially the prostate. Nevertheless, this localization still accounted for nearly 3 out of 5 reported cases overall, a result which is in line with epidemiological data [34].

Although cervix cancer treatment was important in group I (accounting for more than 1 in 6 cases), it was even more common in group II and especially group III (more than half of cases). Similarly, endometrial BT was more common in both groups II and III than in group I. This divergence can at least partially be attributed to differences in incidence rates, similar to the situation described above for prostate cancer. In 2006, the ASR per 100,000 population for cancer of the uterus (including both the cervix and corpus uteri) in group I countries (EU-25) was 28.3; however, the ASR for Europe as a whole (including most of the group II/III countries), was 33.5, indicating a somewhat higher incidence rate in those countries [27].

Treatment intent for gynaecological cancer varies by tumor location. The vast majority of treatments for the endometrium were postoperative (9/10 cases). In general, preoperative intent was the least common type of intervention, accounting for less than 6% of cases, with the notable exception of the cervix (14% of cases). These findings confirm the clinical reality that the use of preoperative BT in gynaecological cancers is limited to certain specific cases, such as stage IB1 cervix cancer, where preoperative BT is included among the various treatment options [35].

Breast cancer

The incidence of breast cancer in Western Europe increased from 84.6 cases per 100,000 population in 2002 to 110.3 in 2006 [27,28], making this site (429,900 cases; 13.5% of all cancer cases) the most common in Western Europe according to Ferlay et al. [27]. These same authors concluded that this high incidence in the EU-25 is probably due to screening programs in wealthier countries. Our study seems to corroborate the regional differences in incidence rates between Western and Eastern Europe. From 2002 to 2007, there was a 41% increase in the average number of breast cancer treatments per centre (from 27 to 38 pts) in group I. In contrast, centres in group II treated only 25 pts/centre.

Although breast BT accounted for nearly 1 out of 11 BT patients overall, its use was highly variable. As our results show, the use of breast BT in group I was more than double that of group II, while accounting for less than 1% of breast treatments in group III. Substantial variability was observed even within group I. In several countries, breast BT made up close to 1 in 4 cases (Austria, Belgium, Italy, Portugal), while in others it accounted for only a small percentage of treatments; in the Netherlands, treatments at this site accounted for slightly more than 3% of interventions, and less than 1% in the UK.

Our findings show that although BT is typically used as a boost following external radiotherapy, APBI is also common and accounts for nearly 1 out of 3 cases. The appeal of APBI vs. whole-breast RT is clear, as it offers multiple benefits in terms of cost, time, and integration with systemic treatments. Clinical trials that have compared APBI to whole-breast irradiation show that results are similar when proper patient selection and quality assurance is performed, though findings from larger trials—currently underway—are needed [36,37]. Recent studies have reported the benefits of HDR BT for APBI [38,39] and if further evidence continues to support this indication, its use is likely to continue to grow. Both the GEC-ESTRO and the American Society for Therapeutic Radiation Oncology have recently published recommendations for the use of this technique [36,40].

Technique and afterloaders

HDR was the most commonly used technique overall, with nearly two-thirds of centres reporting its use. It is especially common in gynaecological treatments, particularly in groups II and III, as Table 2 shows. In group I, the use of HDR remained stable from 2002 to 2007, while VLDR came to represent 20% of treatments vs. zero in 2002.

HDR machines accounted for 63% of afterloaders and a large portion of the remaining afterloaders—nearly 1 out of 5—were for PDR. LDR/MDR units represented a very small percentage of these machines, and are being replaced by PDR and HDR units as production and maintenance for LDR/MDR units is gradually withdrawn [41]. Not surprisingly, the use of LDR in group I declined dramatically (from just under 25% in 2002 to 12% in 2007).

Concluding remarks

Limitations of this study include the fact that the data were self-reported by each centre with no independent quality assurance. In addition, in those countries in which the overall response rate was substantially less than 100%, we cannot assume that the data collected provide an accurate representation of BT practice. Furthermore, there were some differences between 2002 and 2007 in the questionnaire and in the countries included in the final evaluation.

Among the most important observations described in this paper are the relative increase in prostate and breast brachytherapy and the slower (though continued) growth of gynaecological BT. The use of BT appears to be increasing, especially for prostate cancer. We have also found an increase in the types of dosimetric techniques being used. CT-dosimetry, in particular, has increased significantly and increases have also been observed for the use of MRI, PET-CT, and ultrasound. HDR and PDR techniques have increased markedly, while the use of both LDR and MDR has declined. Finally, it is encouraging to observe that 60% of centres adhere to the GEC-ESTRO recommendations for gynaecological care.

There are many factors—financial resources, historical and cultural differences, organizational issues—that account for regional variability in brachytherapy practices, and an additional investigation into these differences is desirable. The large amount of data collected in this study will permit additional analysis that may provide more insight into specific aspects of BT practices and variability, as occurred with the data obtained in the 2002 survey [6,8,10,11,42].

The results of this survey provide a more complete understanding of current practices in brachytherapy in the European area. These findings may be of interest to health care practitioners and planners, although the data should be interpreted alongside the results of other published studies, including clinical trials and reviews. It would be valuable to periodically carry out this pattern of care survey to monitor ongoing changes in tumor sites treated, type of treatments, staffing, and equipment. Such information may be helpful in identifying variations between actual clinical practice and published guidelines.

Conflict of interest statement

The authors have no conflicts of interest to declare.
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