

Radiation therapy in Ukraine with focus on procurement planning

Evgeniy Gonchar

Head of Unit for Policy Development in
Medical Guarantee Program and Medical Provision,
Department of Medical Services.



Healthcare system in Ukraine

- **Healthcare Funding:** In Ukraine, healthcare funding is primarily provided through general taxation, with no specific salary deductions allocated for healthcare.
- **Payment for Medical Services:** National Health Service of Ukraine funds medical services by making payments to healthcare institutions that have signed contracts for the services provided.
- **Provision of Medical Care:** The majority of medical care in Ukraine is delivered by municipal healthcare institutions, with state and private facilities providing a smaller share.
- **Contracts with National Health Service of Ukraine:** Contracts with National Health Service of Ukraine are held by municipal and state healthcare institutions, as well as private facilities, particularly in areas such as radiological treatment.
- **Informal Payments:** There is a high level of informal payments in Ukraine's healthcare sector, although this varies across different types of medical care. The ongoing war has exacerbated the challenges related to funding.
- **Local Government Support:** Local government bodies provide additional funding to healthcare institutions for the acquisition of medical equipment and for other regional programs.
- **Role of Ministry of Health of Ukraine:** Ministry is responsible for developing healthcare policies, overseeing healthcare delivery, and ensuring regulatory compliance across the healthcare sector.
- **Procurement of Medicines and Supplies:** Hospitals generally procure basic medicines and medical supplies independently, primarily using the electronic catalog system. Centralized procurement of chemotherapeutic drugs and other specific items is managed with funds from the state budget. State Enterprise "Medical Procurement of Ukraine" is responsible for the centralized procurement of medical goods

Data sources

In Ukraine, there is a comprehensive and centralized eHealth system. All state-funded healthcare facilities are required to input information necessary for the payment of medical services by the National Health Service of Ukraine (NHSU). Facilities funded outside of the NHSU must also provide certain information.

The eHealth system enables quick and easy access to data for analysis. However, some data may be missing, inaccurate, incomplete, or distorted due to upcoding by healthcare facilities. This presentation uses data from eHealth as well as other sources, including information collected directly from healthcare facilities.

Currently, the primary issue is not the lack of information in eHealth, but the limited capacity to analyze it and make informed decisions based on the analysis.

Additionally, all healthcare facilities are required to submit medical statistics annually, and discrepancies between eHealth data and medical statistics can occur.

Human resources*

- The total number of **physicians specializing in radiation medicine** (including CT, MRI, EBRT, brachytherapy, and nuclear medicine) is **469**. These specialists work across **127** healthcare facilities, providing care at **360** treatment locations.
- The total number of x-ray physicians (mostly X-ray machine, but some work with CT-scan) is **3 843**. These specialists work across **1 511** healthcare facilities, providing care at **3 359** treatment locations.
- The total number of radiation technologists (mostly X-ray machine, but some work with EBRT) is **5 708**. These specialists work across **1 376** healthcare facilities, providing care at **5 708** treatment locations.

**Data from eHealth includes outdated information from temporarily occupied territories, and the names of specializations do not fully correspond to international standards.*

Mapping radiation therapy

Number of patients who completed radiation therapy in Ukraine in 2023:

Total number of patients: 54,136 (including 4,253 with non-cancerous diseases)

Orthovoltage X-rays: 5,242

EBRT with Cobalt-60 machines: 24,207 !!!

EBRT with linear accelerators: 14,869

Brachytherapy: 3,661

Radionuclide therapy: 2,036

Brachytherapy

Model & Manufacturer	Year Made	Total Units	Working Units	Requires installation or charging	Non-working Units, incl. dismantled	No. of patients (2019)	No. of patients (2020)	No. of patients (2021)	No. of patients (2022)	No. of patients (2023)	No. of patients (8 month 2024)
Bravos (Varian Medical Systems Inc.)	2023 - 2024	3	0	3	0	0	-	-	-	-	-
SagiNova HDR (Eckert & Ziegler Bebig GmbH)	2019 - 2023	5	1	4	0	0	-	-	-	-	2
GammaMed iX HD (Varian Medical Systems Inc.)	2010 - 2010	1	0	1	0	0	-	-	-	-	-
Gyne Source (Eckert & Ziegler Bebig GmbH)	2009 - 2009	1	0	1	0	0	-	-	-	-	-
MultiSource® HDR (Eckert & Ziegler Bebig GmbH)	2008 - 2018	7	5	1	1	1	951	904	992	775	752
MicroSelectron HDR V3 (Elekta Limited)	2006 - 2008	2	2	0	0	0	659	499	501	341	298
GammaMed Plus 3/24 (Varian Medical Systems Inc.)	2005 - 2015	5	4	1	0	0	850	912	951	291	1 046
<i>Sum for modern brachytherapy</i>		24	12	11	1	2460	2315	2444	1407	2098	1734
AGAT-BU1 (PO "Baltiets")	1992 - 1994	3	2	0	1	346	249	259	247	318	257
AGAT-B3 (PO "Baltiets")	1987 - 1987	1	1	0	0	42	99	-	-	-	-
AGAT-BU (PO "Baltiets")	1983 - 1992	15	12	0	3	2 549	2 064	2 164	2 343	2 484	1 744
AGAT-B (PO "Baltiets")	1978 - 1986	3	1	0	2	318	422	392	168	190	265
<i>Sum for modern brachytherapy</i>		22	16	0	6	3255	2834	2815	2758	2992	2266
<i>Total sum</i>		46	28	11	7	7	5715	5149	5259	4165	5090

High Costs: In Ukraine, the list price for a brachytherapy unit is approximately \$750,000, with additional expenses for radioactive sources.

Aging Equipment: Many brachytherapy units in Ukraine are outdated. Out of 28 active units, only 12 were manufactured after 2000, affecting treatment efficacy.

Radioactive Source Replacement: The replacement of Iridium-192 sources is costly, around \$32,000 per source, with 2 to 4 replacements needed annually. Logistical and organizational issues often lead to equipment remaining uncharged for extended periods.

Shortage of Skilled Personnel: There is a shortage of trained professionals for brachytherapy in Ukraine, including medical physicists, radiologists, and technicians.

External beam radiotherapy, Cobalt-60

Model & Manufacturer	Year Made	Total Units	Working Units	Non-working Units, incl. dismantled	No. of patients (2019)	No. of patients (2020)	No. of patients (2021)	No. of patients (2022)	No. of patients (2023)	No. of patients (8 month 2024)
Terabalt-100/ASC (UJP Praha a.s.)	2013 - 2022	2	2	0	1 650	1 157	1 250	1 353	729	1 011
Theratron Elite 780-C (MDS Nordion Inc)	2006 - 2006	1	1	0	1+	1+	1+	1+	1+	1+
Cobalt-60F FCC-8000F (Shinva Medical Instrument Co.)	2005 - 2008	7	3	4	5 326	4 611	5 051	3 969	2 272	1 588
Theratron Elite 80 (MDS Nordion Inc)	2004 - 2009	5	3	2	2 402	2 209	2 273	2 173	2 498	1 438
Teragam K-01 (Isotrend spol. s r.o.)	2003 - 2005	8	7	1	6 035	5 946	5 529	4 801	4 935	2 815
<i>Sum for modern Cobalt-60 devices</i>					<i>15 414</i>	<i>13 924</i>	<i>14 104</i>	<i>12 297</i>	<i>10 435</i>	<i>6 853</i>
AGAT-R1U (PO "Baltiets")	1999 - 1999	1	1	0	1 064	1 014	1 392	1 291	1 274	1 193
ROKUS-AM (LMEZ "Ravenstvo")	1990 - 1997	3	0	3	326	273	172	-	-	-
AGAT-R1 (PO "Baltiets")	1989 - 1999	12	7	5	5 655	5 725	5 902	5 462	5 556	2 701
AGAT-RM (PO "Baltiets")	1986 - 1988	3	1	2	2 263	1 521	1 236	918	935	804
ROKUS-M (LMEZ "Ravenstvo")	1983 - 1989	5	2	3	3 285	1 614	1 468	386	407	488
AGAT-R (PO "Baltiets")	1978 - 1984	2	1	1	707	931	806	647	643	442
AGAT-S (PO "Baltiets")	1975 - 1993	6	3	3	1 699	1 598	2 518	2 807	2 682	1 238
LUCH-1	1962 - 1971	2	0	2	90	80	100	-	-	-
<i>Sum for soviet era Cobalt-60 devices</i>					<i>15 089</i>	<i>12 756</i>	<i>13 594</i>	<i>11 511</i>	<i>11 497</i>	<i>6 866</i>
<i>Total sum</i>		<i>57</i>	<i>31</i>	<i>26</i>	<i>30 503</i>	<i>26 680</i>	<i>27 698</i>	<i>23 808</i>	<i>21 932</i>	<i>13 719</i>

External beam radiotherapy, Cobalt-60

Year of Last Cobalt-60 Source Replacement	Number of Units	No. of patients (2023)
2024	1	-
2023	0	-
2022	0	-
2021	1	610
2020	5	3 103
2019	8	4 982
2018	6	4 631
2017	4	4 639
2016	3	2 257
2015	0	-
2014	1	647
2013	1	643
2012	0	-
2011	1	420
<i>Sum</i>	<i>31</i>	<i>21 932</i>

Challenges for External Beam Radiotherapy with Cobalt-60 in Ukraine include:

- **Competition with Modern Technologies:** The global shift towards advanced radiotherapy technologies, such as linear accelerators (LINACs), makes Cobalt-60 appear less precise and less relevant, impacting its funding and support.
- **Aging Equipment:** A significant portion of Cobalt-60 units in Ukraine are outdated. Of the 31 active units, only 16 were manufactured after 2000, and only one unit is equipped with a treatment planning system, limiting its clinical effectiveness.
- **Radioactive Source Replacement:** The periodic replacement of Cobalt-60 sources is costly, approximately \$500,000, and import restrictions on Russian goods complicate the process, making it nearly impossible for healthcare facilities to replace sources.
- **Limited Access to Maintenance:** Regular maintenance of Cobalt-60 machines is challenging due to a shortage of skilled technicians and difficulties in obtaining spare parts.
- **Safety Regulations:** Compliance with stringent international and national safety protocols for handling, storing, and disposing of radioactive materials imposes additional administrative and financial burdens on healthcare facilities.

In the coming years, approximately 31 Cobalt-60 devices will need to be replaced. Recent efforts have accelerated this replacement process, and existing cobalt bunkers offer the opportunity to install linear accelerators, providing a pathway to modernize and enhance radiotherapy capabilities.

External beam radiotherapy, Orthovoltage X-rays*

Model & Manufacturer	Year Made	Total Units	Working Units	Requires installation	Non-working Units, incl. dismantled	No. of patients (2019)	No. of patients (2020)	No. of patients (2021)	No. of patients (2022)	No. of patients (2023)	No. of patients (8 month 2024)
TERAD 200 (NVPUP 'ADANI')	2018 - 2022	3	2	0	1	223	110	245	403	548	30
Xstrahl 200 (Xstrahl L.T.D.)	2019 - 2023	3	2	1	0	0	0	0	17	128	324
Xstrahl 150 (Xstrahl L.T.D.)	2023 - 2023	1	1	0	0	0	0	0	0	1+	1+
T-160 (Eckert & Ziegler Bebig GmbH)	2013 - 2016	1	1	0	0	23	32	92	153	70	40
Sum for modern orthovoltage X-rays devices						246	142	337	573	746	394
RTA-02 (Sevkavrengen)	1988 - 1996	9	5	0	4	953	992	622	577	809	553
MFT-60 (Medicor)	1981 - 1982	1	0	0	1	4	1	3	2	0	0
RUM-21M (Sevkavrengen)	1984 - 1986	4	4	0	0	910	939	978	715	902	469
RUM-21 (Sevkavrengen)	1976 - 1987	5	2	0	3	870	541	428	408	473	303
RUM-7 (Mosrentgen)	1958 - 1976	9	5	0	4	808	678	731	368	551	296
RUM-21 (Sevkavrengen)	1976 - 1987	5	2	0	3	870	541	428	408	473	303
RUM-17 (Mosrentgen)	1968 - 1994	23	11	0	12	4 207	3 232	3 323	1 841	1 922	973
RUM-11 (Mosrentgen)	1960 - 1971	1	0	0	1	20	9	0	0	0	0
TUR-60 (Wandler- und Transformatorenwerk Wirges)	1959	1	0	0	1	92	0	0	0	0	0
Sum for soviet era orthovoltage X-rays devices						8 734	6 933	6 513	4 319	5 130	2 897
Total sum		66	35	1	30	8 980	7 075	6 850	892	5 876	3 291

* Information is missing for some of the modern devices, so the actual number of treated patients is likely higher, though probably not significantly. The provided data pertains not only to patients with oncological conditions but also to those with other health issues.

The list price of modern X-ray machines in Ukraine is approximately \$500,000 for the Xstrahl 200 (Xstrahl L.T.D.), \$415,000 for the T-160 (Eckert & Ziegler Bebig GmbH), and \$450,000 for the TERAD 200 (NVPUP 'ADANI').

External beam radiotherapy, Orthovoltage X-rays



The stationary therapeutic X-ray apparatus TUR-60, manufactured in 1959 by the "Transformer and X-ray Equipment Factory," Dresden, German Democratic Republic, was installed and put into operation at the Poltava Regional Clinical Oncology Dispensary in 1959. Last patient in 2022 year.

External beam radiotherapy, LINACs

Model & Manufacturer	Year Made	Total Units	Working Units	Non-working Units, incl. dismantled	No. of patients (2019)	No. of patients (2020)	No. of patients (2021)	No. of patients (2022)	No. of patients (2023)	No. of patients (8 month 2024)
Harmony (Elekta Limited)	2023 - 2024	15	-	15	-	-	-	-	-	-
Versa HD (Elekta Limited)	2021 - 2024	8	6	2	-	-	-	-	90	159
Infinity (Elekta Limited)	2014 - 2021	4	3	1	-	513	665	793	841	1 158
Synergy Platform (Elekta Limited)	2012 - 2020	3	3	-	-	769	806	794	746	1 113
Synergy/S (Elekta Limited)	2011 - 2020	2	1	1	-	132	136	138	124	162
Synergy (Elekta Limited)	2007 - 2012	3	2	-	1	942	996	1 018	738	1 196
Precise Treatment Systems (Elekta Limited)	2011 - 2011	1	1	-	-	294	272	285	285	370
	Sum	36	16	19	1	2 650	2 875	3 028	2 824	4 158
Halcyon (Varian Medical Systems Inc.)	2019 - 2023	14	12	2	-	-	410	486	2 298	5 001
TrueBeam STx (Varian Medical Systems Inc.)	2019 - 2019	1	1	-	-	-	205	456	204	635
TrueBeam (Varian Medical Systems Inc.)	2012 - 2012	1	1	-	-	-	35	108	158	219
UNIQUE Power (Varian Medical Systems Inc.)	2013 - 2018	2	2	-	-	462	655	1 009	941	824
Trilogy (Varian Medical Systems Inc.)	2007 - 2011	2	2	-	-	1 457	1 208	1 378	1 076	1 252
Clinac 2100C/D (Varian Medical Systems Inc.)	2007 - 2010	2	1	-	1	1 215	1 064	995	870	629
Clinac iX (Varian Medical Systems Inc.)	2011 - 2011	2	1	-	1	308	225	210	88	300
Clinac 600C (Varian Medical Systems Inc.)	2008 - 2008	1	1	-	-	1 258	1 131	1 406	648	1 145
Novalis TX (Varian Medical Systems Inc.)	2011 - 2011	1	1	-	-	290	218	211	282	203
Clinac DMX (Varian Medical Systems Inc.)	2007 - 2007	1	1	-	-	-	-	-	-	-
Clinac 2100C (Varian Medical Systems Inc.)	2008 - 2008	1	1	-	-	343	369	304	134	139
	Sum	28	24	2	2	5 333	5 520	6 563	6 699	10 347
TomoTherapy HD (Accuray Inc.)	2011 - 2011	1	1	-	-	262	262	254	229	335
CyberKnife (Accuray Inc.)	2009 - 2009	1	1	-	-	121	118	122	46	58
	Sum	2	2	-	-	383	380	376	275	393
Oncor Impression Plus (Siemens)	2007 - 2008	3	2	-	1	982	1 119	1 159	922	1 088
Всего		69	44	21	4	9 348	9 894	11 126	10 720	15 986

LINACs year made

According local and international experience LINAC should be replaced after 10 – 15 years of working.

Year Made	Total Units	Non-working Units, incl. dismantled	Requires installation	Working Units
2007	5	1	0	4
2008	4	0	0	4
2009	1	0	0	1
2010	1	1	0	0
2011	8	2	0	6
2012	3	0	0	3
2013	1	0	0	1
2014	2	0	1	1
2015	0	0	0	0
2016	0	0	0	0
2017	1	0	0	1
2018	2	0	0	2
2019	2	0	0	2
2020	4	0	1	3
2021	13	0	1	12
2022	3	0	0	3
2023	3	0	2	1
2024	16	0	16	0
Sum	69	4	21	44

Centralized LINACs procurement in 2023

Local List Prices for Hospitals:

Versa HD (Elekta Ltd.): \$2.2 - \$2.6 million USD (7% VAT)

Halcyon (Varian Medical Systems Inc.): \$2.1 - \$2.6 million USD (7% VAT)

Harmony (Elekta Ltd.): \$2.05 million USD (7% VAT)

Expected Price: \$27.7 million USD (0% VAT) for 15 LINACs **or** \$1.84 million USD per unit

Bids Received:

- **Participant 1 with Harmony (Elekta Ltd.)**
 - First Step: \$1.28 million USD
 - Final Bid: \$0.985 million USD (*Winning Bid*)
- **Participant 2 with VenusX (LinaTech LLC)**
 - First Step: \$1.32 million USD
 - Final Bid: \$0.987 million USD
- **Participant 3 with Halcyon (Varian Medical Systems Inc.)**
 - First Step: \$1.44 million USD
 - Final Bid: \$1.25 million USD
- **Participant 4 with Harmony (Elekta Ltd.)**
 - First Step: \$1.53 million USD
 - Final Bid: \$1.53 million USD

Source: <https://prozorro.gov.ua/tender/UA-2023-05-24-015025-a>

Centralized LINACs procurement in 2023



First Harmony (Elekta Ltd.) in Sumy regional oncological dispensary (03 september 2024).

Centralized LINACs procurement in 2023

Recommendations from the Ukrainian experience with centralized LINAC procurement:

- 1) **Create Competitive Procurement Conditions:** Ensure competitive conditions for procurement by establishing clear and detailed technical requirements and understanding the current market situation.
- 2) **Leverage Economies of Scale:** Accumulate demand for linear accelerators to benefit from economies of scale, thereby reducing costs and optimizing procurement.
- 3) **Define Responsibilities Clearly, for example:**
 - Ministry of Health should handle budgeting, policy formulation, and needs assessment.
 - A dedicated procurement agency should manage competitive and efficient tender procedures.
 - Hospitals and regions should be responsible for providing suitable premises and training staff.
4. **Monitor Readiness:** Carefully monitor the readiness of facilities and personnel to operate the new equipment. Ensure proper training and availability of specialists for equipment operation.
5. **Assess Infrastructure Needs:** Decide whether to repurpose existing bunkers for cobalt machines or to construct new facilities. When replacing cobalt machines, make provisions for the continuity of care for patients currently receiving treatment on these machines until the new equipment is fully operational.
6. **Plan for Additional Requirements:** Ensure the provision of planning CT scans and dosimetry services. Determine who will be responsible for procuring these additional components. It is advisable for each facility to have at least two LINACs (same manufacturer?).

Needs estimation for LINACs

- 1) **LINAC Capacity:** Healthcare facilities in Ukraine with LINACs treat an average of 553 patients per LINAC annually (a few years post-installation and with state funding). This figure represents the upper limit of international guidelines (400 – 600). Private healthcare facilities and less experienced centers tend to treat fewer patients, particularly if they do not have a contract with the NHSU.
- 2) **Population-Based Estimation:** According to IAEA guidelines of 1 LINAC per 250,000 people, Ukraine requires over 120 LINACs. This translates into the need for 55 additional LINACs, plus 20 more to replace outdated machines, bringing the total **to 75 units**.
- 3) **Cancer Incidence-Based Estimation:** Radiotherapy is recommended for over 50% of cancer patients. With approximately 50,000 cancer patients in Ukraine requiring radiotherapy, around 91 LINACs are necessary. Currently, 44 LINACs are operational, 21 are in the installation phase, and 20 are outdated. **This leaves a shortfall of 46 units**.
- 4) **Switching Technology Estimation:** Transitioning approximately 22,000 patients from Cobalt-60 machines to LINACs would require 40 LINACs. With 21 already in the installation phase, this number reduces to 23, but 20 outdated machines also need replacement. **In total, 43 LINACs are required for this transition**.
- 5) **Existing Infrastructure:** There are currently 31 Cobalt-60 machines in need of source replacement, and the hospitals where they are located already have bunkers that can be repurposed to install LINACs. **A total of 31 units would be needed for this replacement**.

Thank you

