



Cancer Care in Times of War: Radiation Oncology in Iraq

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Introduction

“The tide of time flow’d back with me,
The forward-flowing tide of time;
And many a sheeny summer-morn,
A down the Tigris I was borne,
By Baghdad’s shrines of fretted gold,
High-walled gardens green and old;”
From “Recollections of the Arabian Nights”
Alfred Lord Tennyson

These are the opening lines of the book *Ten Thousand and One Nights* authored by Sir Harry Sinderson Pasha, founding dean of the Iraqi Royal Medical College, in 1927.¹ More on him later.

Over the past 4 decades, Iraq, a Middle Eastern country with an estimated population of 40 million, has evoked images of conflict, war, and destruction. The purpose of this work is to briefly outline the rich contribution of ancient Mesopotamia to civilization, and medicine in particular, and to summarize the evolution of the country’s health care system and medical education and the current status of cancer care with an emphasis on radiation oncology.

Health Care in Ancient Mesopotamia

The Babylonians enshrined the principles of health care in the Hammurabi Codex, the first known legal code,

developed during the reign of King Hammurabi (1792-1750 BCE). This system outlined the responsibilities of the physician, set fees, and defined coverage.² The Babylonians left detailed accounts of known diseases and their management on cuneiform tablets, as well as depictions of medical interventions (Fig. 1).³ A superb example is given in this detailed description of stroke: “The Mesopotamian physician knew the consequences caused by injuries localized in certain areas of the brain: a lesion in the left hemisphere will produce aphasia, while if the wound is located on the right side, the patient will suffer a paralysis on the left side of his body. In addition, he prognosticates the stroke according to the side of paralysis. Right-sided paralysis associated with aphasia carries a gloomier prognosis than the left-sided one.”⁴ They were early anatomists and the first to recognize the 8 lobes of the liver (Fig. 2).⁵

A second phase of development of science and medicine in Iraq came during the era of the Abbasid Empire, the “Golden age of Baghdad,” from the eighth through 10th centuries. The Caliph Harun Al-Rashid established a library named the “House of Wisdom.” His son, Al-Ma’amoon, expanded it such that it became renowned as a great center of learning. It attracted scholars, scientists, physicians, and philosophers from all over the known world. He supported scholars of all interests, physicians included, and embarked on translations of the works Hippocrates and Galen, among others. Arabic became the lingua franca of the scientific world. The Caliph Al-Muktafi (r. 902-908 AD) invited Muhammad ibn Zakariya Al-Razi (c.854-c.925 AD),

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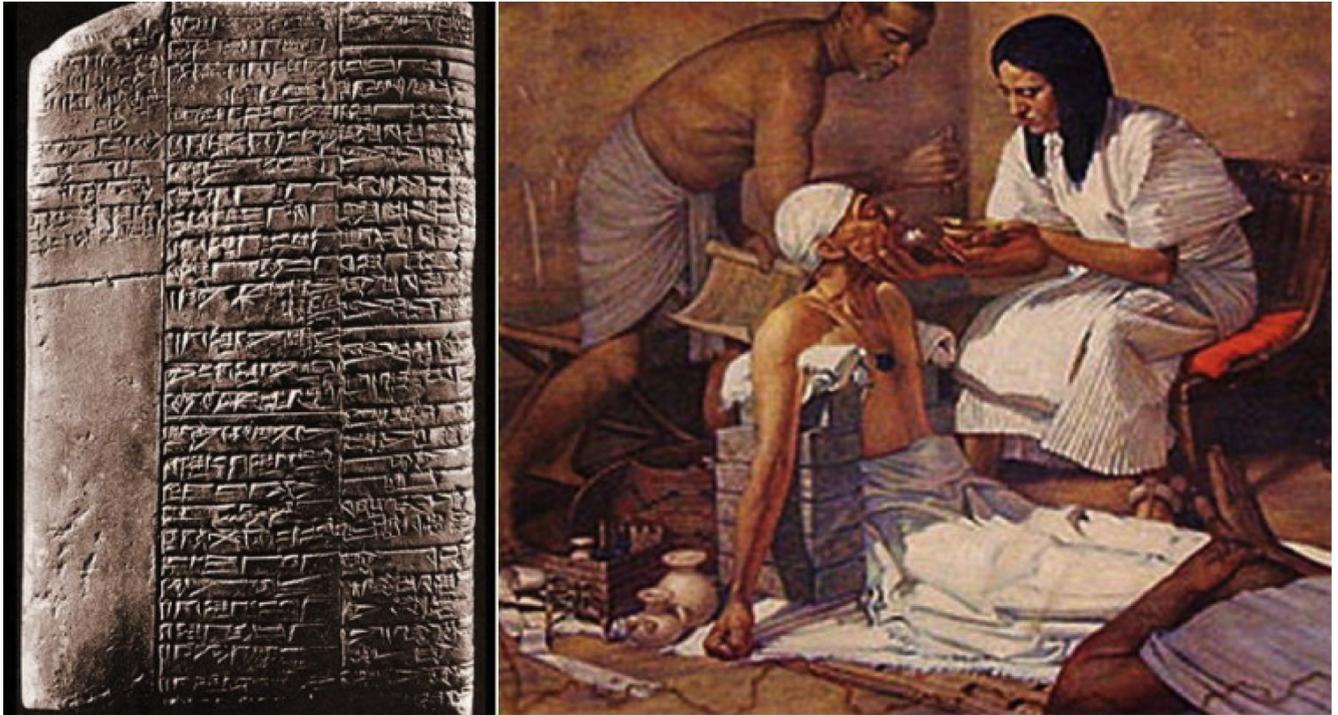


Fig. 1. Left: Sumerian cuneiform medical clay tablet from Nippur c. 2200 BCE is considered the oldest known Sumerian medical book. Right: Treatment of a patient. (Used under the fair use act: <https://www.copyright.gov/fair-use/more-info.html>.)

known as Razes in the West. He was appointed chief physician and entrusted with establishing the first hospital in Baghdad. Al-Razi took pieces of meat and placed them in various parts of the city for several days. After examining them, he decided to locate the proposed hospital at the site where the piece of meat was least affected by the air. He

went on to publish on many areas of medicine and was recognized as the greatest Muslim physician of all time. He is credited with practicing evidence-based medicine and conducting the first known prospective clinical trial.⁶

Very little is known about the period between the fall of Baghdad at the hands of Hulago (Genghis Khan's

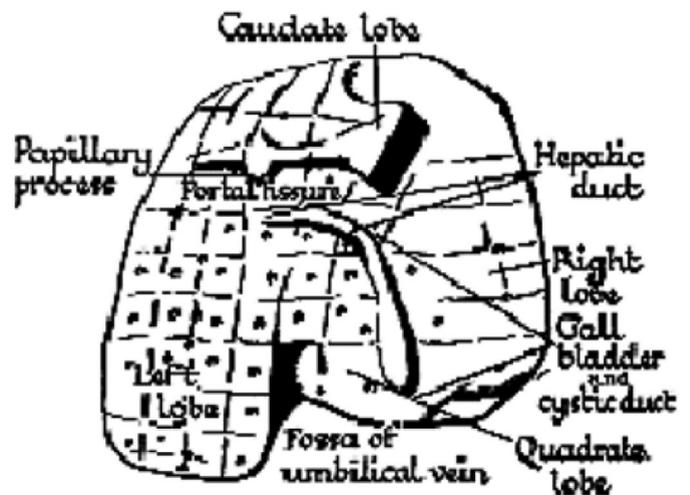


Fig. 2. Clay model of a sheep's liver with explanation to the right (Babylon 2000 BC, British. Museum). (Used under the fair use act: <https://www.copyright.gov/fair-use/more-info.html>.)

grandson) in 1258 and the beginning of the 20th century. This is because after Hulago's invasion, Mesopotamia became an area of competing interests for the then rising powers (Mughals, and Ottomans in particular), finally falling under the influence of the Ottoman Turks, who transferred the center of Islamic rule to Istanbul. These 600 years were a period of decline for Baghdad and lasted until the beginning of the 20th century. The Ottoman governor of Baghdad did, however, establish its first modern hospital in the late 19th century.⁷

Health Care, Medical Education, Cancer Care and Radiation Oncology in Modern Iraq (1920-1990)

After World War I, modern Iraq moved from Ottoman control to British occupation and, in 1932, on to independence. In parallel, a health system started to take shape. The physicians and surgeons working in that era were mostly international doctors, and the remainder were Iraqis who trained in medicine outside Iraq. Notable among the latter was Dr Hanna Khayyat, who was trained at the American University of Beirut in the late 19th century and in infectious diseases in Paris. He established the first health directorate in Baghdad in 1921, which later became the national Ministry of Health. This coincided with the creation of the Baghdad Medical Society, renamed later as the Iraqi Medical Society. It emphasized the importance of establishing medical education institutions in Iraq. In 1925, the *Baghdad Medical Review*, the first Iraqi medical journal, was published. Two years later, the Iraqi Royal Medical College, the first medical school in Iraq, was founded. Sir Harry Sinderson Pasha, a British physician who had come to Iraq as part of the invading British army in World War I and was a physician to the Iraqi Royal family at the time, was appointed as its first dean.^{7,8} Iraqi Royal Medical College later became the College of Medicine, one of the constituent colleges of the University of Baghdad in 1957. Gradually, medical education and the health care system in the country started developing, not only in the capital of Baghdad, which became a hub for those seeking advanced medical care from the neighboring countries, but also in other major cities such as Mosul, Sulaimani, and Basra.

From 1960 to 1990, the health of the population measurably improved. Infant mortality fell by about two-thirds (from 117 to 40 deaths per 1000 births) and child mortality fell by 70% (from 171 to 50 deaths per 1000 births).⁹

Cancer care, like many other tertiary care aspects in Iraq, grew gradually. The Radiology Institute in Baghdad (for diagnostic and therapeutic purposes) was opened in the 1920s.¹⁰ Iraq was a pioneer in this regard compared with other Middle Eastern countries.¹¹ Three decades later, deep x-ray units were installed in Baghdad and then at the Mosul Radiology Institute. Many of the government-sponsored Iraqi oncologists who were sent to study in the United

Kingdom returned after obtaining their specialization in oncology and radiation therapy (RT) and started to develop cancer care into a distinct specialty. The Oncology and Nuclear Medicine Institute was opened in Baghdad in the 1960s, followed by similar institutes in Mosul and Basra in the 1970s.¹² Although private clinics and hospitals do exist in Iraq, health care and education, including medical education and postgraduate studies, are generally free to all Iraqi nationals. Complex operations and procedures are mainly available in public sector hospitals (eg, open heart and neurosurgical operations, cancer care). Oncology services, including external beam, brachytherapy, and chemotherapy, were regarded as very modern in what is termed the new "golden era" of the 1980s at the Baghdad Oncology and Nuclear Medicine Institute. The health system developed rapidly, was fully funded by the government, and focused on a highly centralized, hospital-based, capital-intensive model of curative care.¹³

In the mid-1980s, the Ministry of Health legislated the establishment of the Iraqi Cancer Board. The Iraqi Cancer Board further refined the cancer registry work (which was started in the 1970s by the Iraqi Cancer Society) to guide delivery of needed services. Contemporaneously, and following the British clinical oncology training model, the College of Medicine at the University of Baghdad started its postgraduate diploma in medical radiation therapy, where the residents pass through supervised training in clinical oncology (medical and radiation oncology). This was the first oncology education program. It helped to enrich the field, producing a large number of practitioners in modern oncology.¹⁴

From 1980 to 1988, Iran and Iraq fought a bitter war that, although devastating, was largely confined to the border area. The government maintained a semblance of normality in urban centers, continuing to build hospitals and public services using oil revenues while borrowing heavily from Gulf nations to fund the war effort. Traumatic as the war was, it resulted in neither a destabilizing refugee crisis nor widespread infrastructure destruction. Although physicians were conscripted to the military, they were able to return to their practices once their terms of service were complete, and oncologic care continued to be delivered normally.

1991 to 2010

The onset of the first Gulf War (1990-1991) was a very different proposition and initiated a rapid decline in health indicators. Shortages of food and medicines and limited access to essential goods became very serious due to the embargo and sanctions placed on the country. From a radiation oncology perspective, most relevant devices, scanners, and isotopes were judged "dual use" (ie, having the potential to be weaponized). Their import was thus prohibited. Many hospitals and health centers were themselves structurally damaged during the western coalition

invasions, first in 1991 and then in 2003. A large number of medical personnel fled the country over this period, and financial resources for the health sector declined precipitously. The supply of electricity became erratic as a result of bombing that progressively destroyed the national grid. This alone made many health facilities nonfunctional or ineffective. Health sector imports (particularly medicines and medical equipment) fell from US\$500 million in 1989 to US\$50 million in 1991. Overall health spending per capita fell from a minimum of US\$86 to US\$17 in 1996. The capacity of the curative health system was, by the late 1990s, greatly reduced.^{9,15}

As in so many aspects of life, cancer services disintegrated as well. Many cases were diagnosed at late stages, with limited chance of cure. Treatment facilities deteriorated rapidly due to lack of maintenance and spare parts. Brachytherapy machines became useless due to the inability to import isotopes and to change sources, and functioning mega-voltage machines (MVMs) became few and obsolete. All this, while the rest of the world was advancing toward 3-dimensional and intensity modulated radiation therapy. Karol Sikora, cancer program chief at the World Health Organization wrote

It was immediately clear that there were staggering deficiencies in cancer treatment facilities because of the United Nations sanctions, which are intended to exclude food and medicines. A cancer centre without a single analgesic; a radiotherapy unit where each patient needs one hour under the machine because the radiation source is so old; and children dying of curable cancers because drugs run out are all accepted as normal. Somehow cancer care has become a Cinderella service. Requested radiotherapy equipment, chemotherapy drugs, and analgesics are consistently blocked by United States and British advisers. There seems to be a rather ludicrous notion that such agents could be converted into chemical or other weapons. Whatever the political legitimacy of the embargo, the needless suffering of those with cancer is an unacceptable outcome.¹⁶

Despite there being 28 medical schools in the country with free tuition,¹⁷ brain drain proved to be a significant issue. Many physicians and academicians left the country after 1991 (mainly because of financial and professional development concerns), and this hemorrhage intensified after 2003 (mainly because of security and political concerns). The rate of emigration peaked in 2006, when 60% of all physicians left the country for security reasons, with just 17% wanting to return, as reported by Nabil Al-Khalisi, who did a cross-sectional study of 365 expatriate Iraqi physicians in 2013 and noted their descriptions of better work atmosphere, job satisfaction, and professional development opportunities as principal reasons for migration.¹⁸

The hopes of some that regime change in 2003 might lead to progress in other nonpolitical aspects of Iraqi life,

including the health care system, turned out to be a dream as the country passed through one of the most difficult periods in its history. As far as RT is concerned, we can report that from 1991 through 2005, there were only 4 functional MVMs across the whole country (2 in Baghdad and 2 in Mosul). This increased in 2010 to 6 functional MVMs.¹⁴ For this reason alone, many Iraqi patients with cancer were obliged to seek care outside of their cities, and those who had the means traveled abroad to obtain care.

2011 to Present

With a relative improvement in security and stability across the country after 2011, gradual but significant improvements in cancer care and education became apparent, although anxiety still remained. A 2016 study of 197 Iraqi medical students reported that 62% believed their safety had been threatened due to violent insecurity, and the majority (56%) still intended to leave Iraq after graduation.¹⁹ Despite these understandable fears, some Iraqi physicians and health care professionals have begun to return from abroad to build new educational programs. The Iraqi Board for Medical Specialties initiated a medical oncology residency pathway over 5 years in 2012. In the Kurdistan autonomous region, the Kurdistan Board of Medical Specialties started a 4-year radiation oncology residency program in 2013. The Arab Board of Health Specialties, as well as Iraqi Board for Medical Specialties, initiated a surgical oncology fellowship pathway over 3 and 2 years, respectively, in 2019; the latter will add a 4-year radiation oncology residency program in 2020. Additionally, a 3-year pediatric oncology fellowship started a decade earlier.^{12,14,20}

The 6 MVMs in 2010 doubled in number by 2015 and tripled to a total of 20 in mid-2020, 2 of them in the private sector. There is 1 high-dose-rate brachytherapy suite employing Co-60 at Zhanawa Cancer Center in Sulaimani. [Figure 3](#) depicts the distribution of the functional units as of 2020. The current total number of MVMs remains inadequate for the population. Based on an expected incidence of 36,000 new cancer cases in 2020, with 50% needing radiation, and assuming that each MVM can accommodate up to 500 RT courses per year, then 36 MVMs are needed. This is supported by the IAEA recommendations of 1 MVM/million population (ie, 40 MVM would be recommended for Iraq). Currently there is only 0.5 MVM/million population. This is to be compared with Western Europe (5.5 per million) and the United States (8.8 per million).^{21,22} The shortage of RT facilities is reflected in the long waiting list that ranges from a few weeks to a few months, often changing the curable intent of treatment to palliative.

To date, there is no comprehensive cancer care complex staffed by physician–scientists in the entire country, despite a plan to locate such a center in the capital,

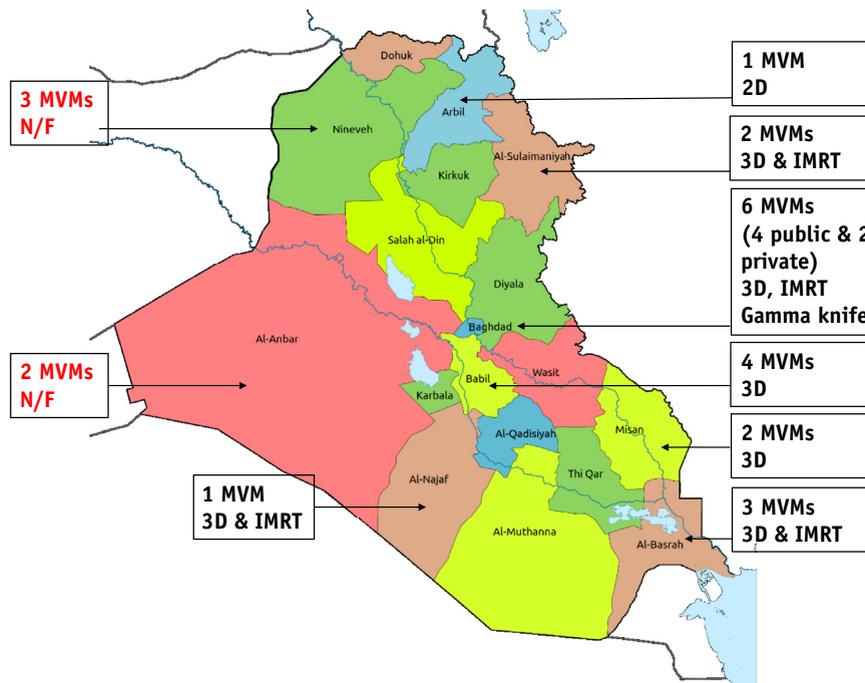


Fig. 3. Iraq map with mega-voltage machines distribution as in mid-2020. (Used under the fair use act: <https://www.copyright.gov/fair-use/more-info.html>.)

Baghdad, in 2002—this was halted by the invasion and subsequent occupation and devastation of the country.¹⁴ Medical oncology is a little more advanced, with centers in almost every province, some offering RT services. There continues to be a shortage of supplies and drugs. Many patients have to procure their prescriptions from local pharmacies or from outside the country at their own expense. Some patients are still seeking cancer care beyond the borders at their own expense.²³

According to the latest annual report of the Iraqi Ministry of Health in 2017, there are 128 cancer physicians in the country (52 medical oncologists and 76 clinical radiation oncologists).²⁴ Clinical oncologists are licensed to offer both radiation and chemotherapy similar to the British model mentioned earlier. This amounts to 3 to 4 cancer specialists per million population (vs 8-12 per million population internationally). An additional 320 cancer RT specialists are needed in the short term, a need that will only grow owing to the increasing population and increased cancer detection. Similarly, there is a shortage of surgical oncologists, medical physicists, oncology nurses, nutritionists, dietitians, and psychotherapists.²⁵

The rise of the Islamic State in Iraq and Syria during 2014 to 2017 had a very negative impact on all aspects of life, including cancer care, and proved a major setback. The Hiwa Cancer Hospital in Sulaimani in Kurdistan has, since 2014, treated hundreds of internal refugees in that province, as well as patients who travel back and forth from their places of origin. Thirty-five percent of its patients were originally residents of another province.²⁶ The

3 MVMs in Mosul, the second largest city in the country, are no longer functional, despite its liberation 3 years ago. The same applies to the 2 nonfunctioning MVMs in Ramadi, the capital of Anbar province.²⁰ These 5 machines were planned to serve a total of 7 million people in 3 governorates (Ninevah, Salah-Eddin, and Anbar), but currently these patients must travel elsewhere for treatment. Mac Skelton, in his study addressing Iraqi patients with cancer receiving care in Lebanon, showed that 48% relied on the sale of possessions and 30% on the sale of homes or on vast family networks to raise the necessary funds. His analysis revealed several key repeating drivers of cross-border treatment, including the conflict-driven exodus of Iraqi oncology specialists; the destruction of hospitals or road blockages; referrals by Iraqi physicians to Lebanese hospitals; the geographic proximity of Lebanon; and the lack of diagnostic equipment, RT machines, and reliable provision of chemotherapy in Iraqi hospitals.²³

Cancer Trends in Iraq

Cancer is the third leading cause of death in Iraq (after stroke and heart disease). The crude incidence rate has doubled over 4 decades (from 40.19/100,000 in 1979 to 82.62/100,000 in 2018). There were 31,502 registered cases in 2018 (57% female, 43% male). Deaths resulting from cancer were 10,293 (49% female, 51% male). The top 10 cancers (65% of total) were breast, lung, colorectum, blood,

urinary bladder, central nervous system (CNS), thyroid, non-Hodgkin lymphoma, skin, and prostate. The top 10 fatal cancers (73% of total) were lung, breast, blood, CNS, colorectum, stomach, liver, pancreas, urinary bladder, and non-Hodgkin lymphoma. The female age group most affected by breast cancer was those aged 45 to 55 years.²⁷ Blood and CNS cancers were ranked fifth and eighth in the 1998 cancer registry, respectively. These became second and fourth in 2004, third and fifth in 2010, and fourth and sixth in 2018. These interesting trends might be related to heavy weapons that were used during the invasion and subsequent occupation of Iraq in 2003.^{25,28} The mortality to incidence ratio from the aforementioned data is 0.33.

Cancer treatment is based on stage at presentation. The Iraqi cancer registry lacks this information in its annual reports. A report from Northern Iraq in 2009 showed that patients with stage I breast cancer constitute ~4.1%, whereas those with stage II to IV constitute ~77.6%. There were 18.2% with unknown stage.²⁹ A report from Baghdad in 2010 stated that ~8% of patients with breast cancer receive a diagnosis of stage I disease and 92% stage II to IV.³⁰ A recent cross-sectional study from Baghdad in 2018 showed that stage I presented in 4.3%, stage II in 27.8%, stage III in 43.9, and stage IV in 25%.³¹ These findings need to be validated in a population-based registry; from there, we can understand the mode of presentation in Iraqi patients with cancer.

There are no survival and control rates in these reports. The Global Cancer Observatory³² offers an estimate of the number of new cases and deaths from cancer globally. It is possible to compare Iraq's indices with Jordan, a neighboring country; the United States, as a model of developed countries; other countries of similar high-middle income and medium human development index; and with the countries in general. Using the 2018 report, we arrive at the numbers in Table 1. There are obvious differences between the registered numbers in the 2018 Iraqi annual report and estimated numbers from the Global Cancer Observatory: The incident cases are 20% lower (31,502 vs 25,320) and the deaths are 41% higher (10,293 vs 14,524). Based on these differences, the mortality to incidence ratio itself is between 0.33 and 0.57. More reliable Iraqi cancer statistics are clearly required.

Summary

Iraq has passed through prosperous and tumultuous periods over the last century that have affected the life of its people, including the health sector in general and cancer services in particular. Over the last 30 years, Iraq has lost many of its doctors to emigration, a problem that continues. This needs to be addressed to stop, and ideally reverse, the drainage of trained talent. Over the same period, cancer care suffered grievously from decades of war, embargo, sanctions,

Table 1 Basic cancer statistics of the top 5 cancers in Iraq, compared with Jordan, MHDIC, UMIC, world countries, and the United States

Measures	Iraq	Jordan	UMIC	MHDI	World	US
Population	39,339,754	9,903,798	2,624,829,865	2,758,985,732	7,632,819,272	326,766,750
New cases	25,320	10,898	7,019,867	2,828,475	18,078,957	2,129,118
Deaths	14,524	5,813	4,310,275	1,861,723	9,555,027	616,714
MIR	0.57	0.53	0.61	0.66	0.53	0.29
Previous 5 y	54,809	25,497	14,192,557	5,491,922	43,841,302	7,279,710
ASIR	105.5	157.8	197.4	112.8	197.9	352.2
ASMR	64.7	89.7	116.9	75.5	101.1	91.0
RDvCB75Y	11.17%	16.16%	20.3%	11.9%	20.2%	33.3%
RDyCB75Y	7.07%	9.41%	12.5%	8.2%	10.6%	9.64%
Top 5 cancers in males	Lung	Lung	Lung	Lung	Lung	Prostate
	Bladder	Bladder	CRC	Lips, oral cavity	Prostate	Lung
	Blood	CRC	Stomach	CRC	CRC	CRC
	CRC	Prostate	Prostate	Liver	Stomach	Bladder
	CNS	Blood	Liver	Prostate	Liver	CMM
Top 5 cancers in females	Breast	Breast	Breast	Breast	Breast	Breast
	Blood	CRC	CRC	Cervix/uteri	CRC	Lung
	CRC	Thyroid	Lung	Ovary	Lung	CRC
	CNS	Corpus uteri	Thyroid	CRC	Cervix/uteri	Corpus uteri
	Lung	Blood	Cervix/uteri	Lung	Thyroid	Thyroid

Abbreviations: ASIR = age-standardized incidence rate (world); ASMR = age-standardized mortality rate (world); CMM = cutaneous malignant melanoma; CNS = central nervous system; CRC = colorectal cancers; MHDIC = medium Human Development Index countries; MIR = mortality to incidence ratio; RDvCB75Y = risk of developing cancer before the age of 75 years; RDyCB75Y = risk of dying from cancer before the age of 75 years.

occupation, uncontrolled security, and mismanagement. There is limited access to optimal cancer surgery, RT, and chemotherapy services, and there is no single comprehensive academic tertiary cancer care institute staffed by clinician–scientists. There is an urgent need to improve care facilities, in terms of quality, quantity, accessibility, and acceptability. Improvements in the cancer registry, qualified human resources, financial resources, networking, and collaboration are also necessary. An emerging nongovernmental cancer care sector (for profit or not for profit) requires careful attention to ensure compliance with acceptable standards. Policymakers in Iraq must see the cessation of hostilities as an opportunity to set new health priorities with sustained commitment at the highest level of central and local governments. The current status is well below ideal international standards, and a detailed road map is required by policymakers if we are to comprehensively rectify these shortcomings.

References

- Sinderson Pasha SHC. *Ten Thousand and One Nights*. London: Hodder & Stoughton; 1973.
- Spiegel AD, Springer CR. Babylonian medicine, managed care and Codex Hammurabi, Circa 1700 B.C. *J Community Health* 1997;22:69-89.
- Kramer SN. *History Begins at Sumer*. Philadelphia, PA: University of Pennsylvania Press; 1956.
- Karim SK, Amin OSM. Stroke in ancient Mesopotamia. *Med Arch* 2018;72:449-452.
- Jastrow M. The medicine of the Babylonians and Assyrians. *Proc R Soc Med* 1914;7:109-176.
- Al-Khalili J. *The House of Wisdom: How Arabic Science Saved Ancient Knowledge and Gave Us the Renaissance*. Penguin; 2011; 143-151; 282.
- Al-Fattal S. Sir Harry Sinderson Pasha and Iraq's first medical school. *J Med Biogr* 2013;21:164-168.
- Al-Shamsi M. Medical education in Iraq: Issues and challenges. *Int J Med Educ* 2017;8:88-90.
- Alwan A. Health in Iraq. Baghdad; 2004. Available at: http://www.who.int/hac/crises/irq/sitreps/2004/Iraq_Health_in_Iraq_Dec2004.pdf. Accessed May 1, 2020.
- Al-Ghazi M. Cancer care in a war zone: radiation oncology in Iraq. *Int J Radiat Oncol Biol Phys* 2016;96:E413.
- Mula-Hussain L, Wadi-Ramahi SJ, Zaghoul MS, Al-Ghazi M. Radiation oncology in the Arab World. In: Laher I, editor. *Handbook of Healthcare in the Arab World*. Cham: Springer International Publishing; 2019. p. 1-19.
- Mula-Hussain L, Shamsaldin AN, Al-Ghazi M, et al. Board-certified specialty training program in radiation oncology in a war-torn country: Challenges, solutions and outcomes. *Clin Transl Radiat Oncol* 2019; 19:46-51.
- Mula-Hussain L. War and its consequences for cancer trends and services in Iraq. In: Lutz C, Mazzarino A, editors. *War and Health*. New York: New York University Press; 2019.
- Mula-Hussain L. *Cancer Care in Iraq: A Descriptive Study*. 1st ed. Saarbrücken-Germany: LAP LAMBERT Academic Publishing; 2012.
- Diaz J, Garfield R. Iraq watching briefs (health and nutrition). Available at: http://www.unicef.org/evaldatabase/files/Iraq_2003_Watching_Briefs.pdf. Accessed May 1, 2020.
- Sikora K. Cancer services are suffering in Iraq. *BMJ* 1999;318:203.
- World Federation for Medical Education. World Directory of Medical Schools Search. Available at: <https://search.wdoms.org/>. Accessed April 29, 2020.
- Al-Khalisi N. The Iraqi medical brain drain: A cross-sectional study. *Int J Health Serv* 2013;43:363-378.
- Barnett-Vanes A, Hassounah S, Shawki M, et al. Impact of conflict on medical education: A cross-sectional survey of students and institutions in Iraq. *BMJ Open* 2016;6:e010460.
- Mula-Hussain L, Alabedi H, Al-Alloosh F, Alharganee A. Cancer in Iraq: where do we stand? In: *The 18th Annual Scientific Conference of the College of Medicine – University of Baghdad*. Baghdad: College of Medicine – University of Baghdad; 2019.
- Mousa AG, Bishr MK, Mula-Hussain L, Zaghoul MS. Is economic status the main determinant of radiation therapy availability? The Arab world as an example of developing countries. *Radiation Oncol* 2019;140:182-189.
- Rosenblatt E, Zubizarreta E. International atomic energy agency. Radiotherapy in cancer care: Facing the global challenge. Available at: http://www-pub.iaea.org/MTCD/Publications/PDF/P1638_web.pdf. Accessed May 2, 2020.
- Skelton M, Alameddine R, Saifi O, et al. High-cost cancer treatment across borders in conflict zones: experience of Iraqi patients in Lebanon. *JCO Glob Oncol* 2020;6:59-66.
- Ministry of Health/Environment. 2017 Annual Statistical Report. Baghdad: Ministry of Health/Environment; 2018.
- Mula-Hussain L, Alabedi H, Al-Alloosh F, Alharganee A. Cancer in war-torn countries: Iraq as an example. In: Laher I, editor. *Handbook of Healthcare in the Arab World*. Cham: Springer International Publishing; 2019. p. 1-14.
- Skelton M, Mula-Hussain LYI, Namiq KF. Oncology in Iraq's Kurdish region: navigating cancer, war, and displacement. *J Glob Oncol* 2018; 1-4.
- Iraqi Cancer Registry. 2018 Annual Report - Iraqi Cancer Registry. Available at: <https://moh.gov.iq/upload/upfile/ar/1090.pdf>. Accessed May 1, 2020.
- Mula-Hussain L. Cancer in a war-torn Arab community - Iraq: description of its trends. In: *ACCESS Health Journal (Proceedings of the 7th International Conference on Health Issues in Arab Communities)*. ACCESS Community Health & Research Center; 2015. p. 26-31.
- Majid RA, Mohammed HA, Saeed HM, et al. Breast cancer in Kurdish women of northern Iraq: Incidence, clinical stage, and case control analysis of parity and family risk. *BMC Womens Health* 2009; 9:33.
- Alwan NA. Breast cancer: Demographic characteristics and clinicopathological presentation of patients in Iraq. *East Mediterr Health J* 2010;16:1159-1164.
- Mutar MT, Goyani MS, Had AM, et al. Pattern of presentation of patients with breast cancer in Iraq in 2018: A cross-sectional study. *J Glob Oncol* 2019;5:1-6.
- Ferlay J, Ervik M, Lam F, et al. Global Cancer Observatory: Cancer Today. International Agency for Research on Cancer. Available at: https://gco.iarc.fr/today/online-analysis-table?v=2018&mode=population&mode_population=countries&population=900&populations=900&key=asr&sex=1&cancer=39&type=2&statistic=5&prevalence=1&population_group=0&ages_group%5B%5D=0&ages_group%5B%5D=17&group_cancer=. Accessed March 18, 2020.