

Using Israel's National Cancer Registry Database to Track Progress in the War on Cancer: A Challenge for the Health Services

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ABSTRACT: **Background:** The number of cancer survivors has been increasing worldwide and is now approximately 32.6 million and growing. Cancer survivors present a challenge to health care providers because of their higher susceptibility to long-term health outcomes related to their primary disease and treatment. **Objectives:** To report on the number of cancer survivors and incident cancer cases in the period 1960–2009 in Israel, reflecting the scope of the challenge faced by Israel's health care funds. **Methods:** The Israel National Cancer Registry (INCR) database was used to identify new cancer cases diagnosed during the period 1960–2009. Lifetable analysis was used to assess changes in cumulative survival and population prevalence of cancer survivors throughout the 50 year study period. **Results:** Almost 600,000 invasive cancer cases were diagnosed during the period 1960–2009 (overall absolute survival rate, 54%). Within this time period, the number of new patients diagnosed with cancer increased fivefold and that of cancer survivors ninefold. The absolute survival of cancer patients and the prevalence of cancer survivors in the general population significantly increased with time from 34% and 0.5%, respectively (1960–1969) to 62% and 1.9%, respectively (2000–2009). Cumulative absolute survival for 5, 10 and 15 years following diagnosis increased with time as well. **Conclusions:** The INCR database is useful to assess progress in the war against cancer. The growing numbers of cancer survivors in Israel present a challenge to the national health and social services system.

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which accounts for the full continuum of life following cancer diagnosis, is used in this article.

The number of cancer survivors has been increasing worldwide and will continue to increase in the future due to improvements in screening and early detection, successful public education, development of new treatments, and aging of the world population. In 1971, the number of cancer survivors in the United States was 3 million (1.5% of the total U.S. population); in 2014, this figure had increased to more than 14 million (4% of the total U.S. population) [2]. The projected number for 2022 is expected to approach 18 million [2,3]. According to a report from the International Agency for Research on Cancer (IARC) of the World Health Organization [4], the number of survivors worldwide is now 32.6 million and continues to increase.

The subject of cancer survivors and survivorship is receiving increased attention in the provider and patient communities. In 2012 the American Society of Clinical Oncology (ASCO) [5] established a survivorship committee. The Livestrong Foundation [6] has actively promoted the subject of survivorship, offering resources for targeted research in this area. Many publications and recommendations have been published since the establishment of this forum. The rationale for this growing interest is that cancer survivors are prone to early and late health outcomes associated with their primary disease and its treatment [7,8]. Early effects associated with cancer treatment may be physical, and include fatigue, endocrine imbalance (such as diabetes), pain, dental problems, neuropathy, lymphedema, and cognitive problems. There are also social and emotional side effects, as well as a legal impact [7,8]. The early physical side effects usually disappear sometime after the initial treatment is completed. The late effects may appear years and decades after cancer diagnosis and may include cardiovascular changes, nephrotoxicity, hepatic dysfunction, osteoporosis, and musculoskeletal complications [9–11]. A recent systematic review of the literature compiled data on models predicting late health effects in cancer survivors, which were defined as consequences of treatment that persisted or arose after a latent period. The

The term “cancer survivor” can be defined in many ways. According to the American National Cancer Institute [1], a person is considered to be a cancer survivor from the time of cancer diagnosis until the end of life. This broad definition,

authors identified nine late effects that were predicted by constructed models: erectile dysfunction and urinary incontinence after prostate cancer, arm lymphedema, psychological morbidity, cardiomyopathy or heart failure and cardiac event after breast cancer, swallowing dysfunction after head and neck cancer, breast cancer after Hodgkin lymphoma, and thyroid cancer after childhood cancer [12]. In a previous study, Robinson and colleagues [13,14] found that the most frequent complaints reported by survivors involved fatigue, pain, sleep disorders, cognitive dysfunction, emotional distress, depression, anxiety, family and work disruptions, financial difficulties, and weight change. Furthermore, some cancer survivors have a high risk of recurrence. Cancer survivors are also at risk of developing a second primary tumor and/or hematological malignancies. This risk ranges from 5.2% to 16.8%, depending on the site of the first primary tumor and the type of treatment, according to the U.S. Surveillance, Epidemiology and End Results (SEER) program [15]. Therefore, medical follow-up of cancer survivors should be carried out in a systematic fashion in order to detect these potential complications as early as possible, as localized cancer treatment is known to be more effective than the treatment of regional or metastatic disease. In addition, such treatment can markedly improve the quality of life.

Childhood cancer patients present a special challenge with respect to late health outcomes due to the aggressive treatment regimen often used for initial therapy and for lengthening their lifespan. However, it was recently reported among childhood cancer patients diagnosed in the 1970s and 1980s that due to changes in treatment strategies, the long-term all-cause mortality of 5 year childhood cancer survivors was substantially reduced: from 12.4% in the 15 years following diagnosis in the early 1970s to 6.0% in the 1990s ($P < 0.001$, for trend) [16].

Based on these findings, there is no doubt that depending on the type of cancer, stage at diagnosis, and treatment chosen, cancer survivors have specific needs. Published surveys of cancer survivors indicate that 80% of respondents reported that most of their medical needs were met, but only 67% reported that needs related to their physical function were met, only 54% reported that their emotional needs were met, and only 48% reported that their practical needs were met [13]. Robinson et al. [14] found that interventions aimed at better satisfying the needs of cancer survivors were successful.

The Israel National Council of Oncology, in collaboration with the Medical Association of Family Practitioners and the Oncological Association, have made recommendations promoting the needs of survivors among physicians, nurses, social workers and other medical and non-medical personnel. These recommendations emphasize the necessity for cooperation and coordination between the treating oncologist and the physician within the community [17].

The aim of this study is to report on the number of cancer survivors in Israel in the last 50 years in relation to the inci-

dence of new cancer cases, in order to track our progress in the war against cancer and to provide data on the scope of the challenges that Israel's health and social systems face with respect to cancer survivorship.

PATIENTS AND METHODS

The database of the National Israel Cancer Registry (INCR) was used to derive relevant information on cancer incidence and cancer survivorship for the period 1960–2009. This time period was further divided into five decades (1960–1969, 1970–1979, 1980–1989, 1990–1999, and 2000–2009).

The INCR was founded in 1960 and is a national population-based passive registry. Cancer reporting to the INCR by hospitals, pathology and cytology laboratories, oncology institutes and other health care providers has been mandatory since 1982 for cases diagnosed in Israel. Completeness of ascertainment is high, based on international standards, and has been estimated at 94% for solid tumors [18]. The diagnoses that are recorded in the registry include:

- All malignant invasive neoplasms, excluding basal cell and squamous cell carcinoma of the skin
- Carcinoma in situ/high grade (grade III) intraepithelial neoplasia
- Benign neoplasms of the brain and nervous system.

The Israeli Central Bureau of Statistics provides data on population size (in total and by population and age groups), which enables the calculation of incidence rates. Demographic data and information on vital status are derived from the Central Population Registry of the Ministry of the Interior and updated at least annually, which allows the estimation of cancer survivorship.

In the current study we used absolute numbers of incident cancer cases based on the INCR database. The number of incident cancer cases was determined per decade (equal to the sum of incident cases diagnosed in each of the relevant calendar years) and for the total study period (equal to the total number of incident cancer cases diagnosed in 1960 through 2009). Cancer survivor numbers were calculated for each of these time periods and were based on the absolute number of incident cancer cases diagnosed in each relevant time period, for survivors who were alive at the end of that time period. For example, to compute the absolute number of cancer survivors in the decade 1980–1989, we deduced from the total number of subjects diagnosed with incident cancer during this decade the number of those not alive by 31 December 1989.

The prevalence of cancer survivors per decade and for the entire study period was computed by dividing the number of cancer survivors per relevant time period by the total Israeli population at the end of that time period. For example, the prevalence of cancer survivors for the decade 1980–1989 was

computed as the number of cancer survivors at the end of this decade (31 December 1989) divided by size of the total Israeli population at that time point.

The significance of the time trends of cancer survival and prevalence by decade was assessed using a linear regression model. The percentage of survivors (or prevalence) was used as the dependent variable, and time period as the independent variable, while testing the hypothesis that the percentages did not differ between time periods, at $P < 0.05$.

In addition, the life table analysis approach was used to estimate changes in the cumulative absolute cancer survival for 5, 10 and 15 years following diagnosis by decade. All analyses were done using SAS Version 9.12.

RESULTS

In the 50 years from 1960 to 2009, almost 600,000 Israeli residents were diagnosed with an invasive cancer; the incidence of new patients increased from 40,922 in the first decade to 226,481 in the last decade of the 50 year study period (about fivefold). Of them, 323,809 patients were still alive by the end of 2009, for an overall absolute survival rate of 54%. The number of survivors increased from 15,860 in the first decade to 141,811 in the last decade of the 50 year study period (ninefold). The absolute survival of cancer patients increased with time, from 34% in the decade 1960–1969 to 62% in the decade 2000–2009 ($P = 0.002$, for trend). The prevalence of cancer survivors in the total Israeli population also gradually increased, from approximately 0.5% in the decade 1960–1969 to 1.9% in the decade 2000–2009 ($P = 0.002$, for trend). For the 50 years between 1960 and 2009, the overall prevalence of cancer survivors is estimated at 4.3%. Table 1 presents the data by decade and for the entire study period.

A life table analysis approach was used to assess the change in cumulative survival with time. Table 2 presents data on cumulative absolute survival following diagnosis for 5, 10 and 15 years by decade. Increases with time were observed for the cumulative absolute survival for 5 years (from 34% in 1960–1969 to 62% in 2000–2009), for 10 years (from 25% in 1960–1969 to 54% in 2000–2009), and for 15 years (from 19% in 1960–1969 to 34% in 1990–1999). Figure 1 depicts these trends.

DISCUSSION

The main objective of this study was to describe cancer incidence and survival in Israel in the last 50 years and to use these findings to evaluate the scope of the challenge presented to Israeli health and social services systems. Absolute numbers of incident cancer cases were used because they provide the appropriate information needed to estimate disease burden and demand placed on the health system. Our results show that the number of both newly diagnosed cancer patients and cancer survivors increased significantly with time. The number of new cancer

Table 1. Cancer incidence* and absolute survival (numbers and %) by decades of diagnosis, Israel, 1960–2010

Time period	Incident cases (n) during time period	Cancer survivors (n) by end of time period	Absolute survival (%)**	Cancer survivor prevalence in the population (%)†
1960–1969	40,922	15,860	38.8	0.54
1970–1979	68,338	28,982	42.4	0.76
1980–1989	95,506	44,900	47.0	0.98
1990–1999	165,306	92,256	55.8	1.48
2000–2009	226,481	141,811	62.6	1.88

*Numbers refer to patients, not diagnoses; thus only first primary tumors are included

**Percent of absolute survival was computed as the number of survivors by the end of the relevant time period divided by the number of incident cases in the same time period and multiplied by 100

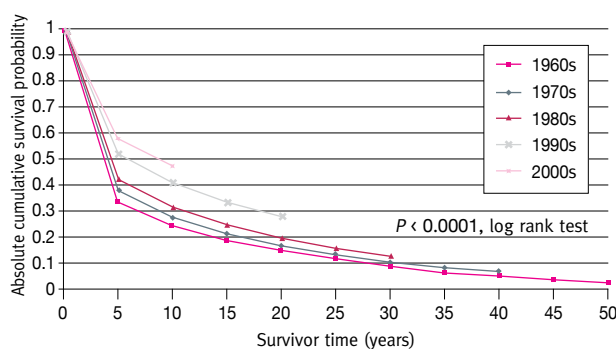
†Prevalence of cancer survivors in the Israeli population was computed by dividing the number of cancer survivors at the end of each time period by the total Israeli population at this time point and multiplied by 100. Relevant denominators are based on the Israeli Bureau of Statistics publications (for 31 December of the year): 2,929,500 in 1969, 3,836,200 in 1979, 4,559,600 in 1989, 6,209,100 in 1999, and 7,552,000 in 2009

Table 2. Cumulative absolute survival for 5, 10 and 15 years following diagnosis by decades of diagnosis in Israel, 1960–2009

Time period	Cumulative absolute survival for 5 years (%)	Cumulative absolute survival for 10 years (%)	Cumulative absolute survival for 15 years (%)
1960–1969	34	25	19
1970–1979	38	28	21
1980–1989	43	32	23
1990–1999	54	42	34
2000–2009	62	54	NA

NA = not available

Figure 1. Life table survival function estimates. Cumulative absolute survival following diagnosis by decades of diagnosis in Israel, 1960–2010



patients in Israel increased fivefold between 1960 and 2009, most likely reflecting population growth (including immigration) and aging, as well as increases in the incidence of certain types of cancer. During the same period, the number of cancer survivors increased ninefold. Cumulative absolute survival for 5, 10 and 15 years following diagnosis increased by decade, sug-

gesting that cancer survivorship genuinely improved with time, most likely as a result of regular screening of the population, earlier diagnosis (of both relevant and non-relevant; that is, less aggressive tumors), and improved treatment.

These findings concur with global trends, as reflected in the recent publication of the Global Burden of Disease Cancer Collaboration [19], which studied mortality, incidence, years lived with disability, years of life lost and disability-adjusted life years for 28 cancer types in 188 countries (Israel included) from 1990 to 2013. Similarly, according to GLOBOCAN 2012 [4], an estimated 14.1 million new cancer cases and 8.2 million cancer-related deaths occurred in 2012, compared with 12.7 million and 7.6 million, respectively, in 2008. Prevalence estimates for 2012 show that there were 32.6 million people alive (over the age of 15 years) who had had a cancer diagnosed in the previous 5 years.

In 1980, Dr. Fitzhugh Mullan and associates founded the National Coalition for Cancer Survivorship in the USA. In 1968, Mullan [20], physician and cancer survivor, reflected on the unmet needs of cancer survivors following their initial treatment, writing, “we have invented sophisticated techniques to save people from drowning, but once they have been pulled out of the water, we leave them on the dock to cough and sputter on their own, in the belief that we have done all that we can.”

In 2005, the American Institute of Medicine released a report entitled: “From Cancer Patient to Cancer Survivor – Lost in Transition” [21]. The report stated that cancer survivors constitute a unique group that experiences ongoing and long-term morbidity associated with their primary malignant disease, its treatment and their background behavioral, genetic and personal characteristics. Their special care needs are yet to be comprehensively assessed [21].

At the European Society for Medical Oncology (ESMO) meeting in Vienna, Austria in 2015, the expected increase in the number of cancer survivors was defined as a “time bomb,” in light of the survivors’ physical, psychological, social and other unmet needs. The ESMO meeting called health services to prepare for this challenge [22].

Our findings are based on the INCR database, and it should be noted that reporting to the INCR became mandatory only in 1982. Allegedly, changes in reporting could have accounted for some of the trends observed. However, the completeness of the INCR data was considered high even before 1982. In addition, at that time most cancer patients were treated in hospitals, which regularly reported to the INCR. Thus, we do not expect this fact to substantially impact on the trends described.

Based on the data presented in this communication, the situation in Israel with respect to cancer survivorship closely follows that in other developed countries. The growing number of cancer survivors in Israel presents an obvious challenge to the Israeli health system and to other service providers expected to meet the special physical, mental, social and other needs of this unique population.

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