

# Baseline status of paediatric oncology care in ten low-income or mid-income countries receiving My Child Matters support: a descriptive study



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## Summary

**Background** Childhood-cancer survival is dismal in most low-income countries, but initiatives for treating paediatric cancer have substantially improved care in some of these countries. The My Child Matters programme was launched to fund projects aimed at controlling paediatric cancer in low-income and mid-income countries. We aimed to assess baseline status of paediatric cancer care in ten countries that were receiving support (Bangladesh, Egypt, Honduras, Morocco, the Philippines, Senegal, Tanzania, Ukraine, Venezuela, and Vietnam).

**Methods** Between Sept 5, 2005, and May 26, 2006, qualitative face-to-face interviews with clinicians, hospital managers, health officials, and other health-care professionals were done by a multidisciplinary public-health research company as a field survey. Estimates of expected numbers of patients with paediatric cancer from population-based data were used to project the number of current and future patients for comparison with survey-based data. 5-year survival was postulated on the basis of the findings of the interviews. Data from the field survey were statistically compared with demographic, health, and socioeconomic data from global health organisations. The main outcomes were to assess baseline status of paediatric cancer care in the countries and postulated 5-year survival.

**Findings** The baseline status of paediatric oncology care varied substantially between the surveyed countries. The number of patients reportedly receiving medical care (obtained from survey data) differed markedly from that predicted by population-based incidence data. Management of paediatric cancer and access to care were poor or deficient (ie, nonexistent, unavailable, or inconsistent access for most children with cancer) in seven of the ten countries surveyed, and accurate baseline data on incidence and outcome were very sparse. Postulated 5-year survival were: 5–10% in Bangladesh, the Philippines, Senegal, Tanzania, and Vietnam; 30% in Morocco; and 40–60% in Egypt, Honduras, Ukraine, and Venezuela. Postulated 5-year survival was directly proportional to several health indicators (per capita annual total health-care expenditure [Pearson's  $r^2=0.760$ ,  $p=0.001$ ], per capita gross domestic product [ $r^2=0.603$ ,  $p=0.008$ ], per capita gross national income [ $r^2=0.572$ ,  $p=0.011$ ], number of physicians [ $r^2=0.560$ ,  $p=0.013$ ] and nurses [ $r^2=0.506$ ,  $p=0.032$ ] per 1000 population, and most significantly, annual government health-care expenditure per capita [ $r^2=0.882$ ,  $p<0.0001$ ]).

**Interpretation** Detailed surveys can provide useful data for baseline assessment of the status of paediatric oncology, but cannot substitute for national cancer registration. Alliances between public, private, and international agencies might rapidly improve the outcome of children with cancer in these countries.

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## Introduction

Until recently, care of children with cancer has been largely neglected in low-income and mid-income countries. An estimated 160 000 new cases of cancer are diagnosed annually in children younger than 15 years of age.<sup>1</sup> Only about 20–30% of patients (mostly in high-income countries) are thought to be adequately diagnosed and treated. A child's probability of surviving cancer is dismal in less developed countries, and extreme discomfort is likely in the absence of palliative care. Paradoxically, most cases of childhood cancer, if diagnosed at an early stage, are highly curable if treatment is available. Furthermore, today's effective treatment regimens are relatively simple, inexpensive, and well established.

Paediatric oncology has improved substantially in some comparatively low-income countries, and therefore, might be improved in other countries as well. Successful initiatives have improved access to treatment in countries in central and south America, Africa, and Asia.<sup>2–9</sup> Collectively, these initiatives are twinning partnerships that pair medical institutions in high-income countries with those in low-income and mid-income countries. These programmes can rapidly improve survival when the collaborating institutions have a long-term commitment and when their efforts are supported locally by alliances between public and private sectors.<sup>7</sup>

On the basis of these successes, the My Child Matters programme was launched by the Sanofi-Aventis

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Humanitarian Sponsorship Department (Paris, France) and the International Union Against Cancer (UICC; Geneva, Switzerland) in collaboration with a consortium comprising the US National Cancer Institute (Bethesda, MD, USA), St Jude Children's Research Hospital (Memphis, TN, USA), the International Network for Cancer Treatment and Research (Brussels, Belgium), the International Society of Paediatric Oncology (Eindhoven, Netherlands), the French-African Paediatric Oncology Group (Villejuif, France), the International Agency for Research on Cancer (IARC; Lyon, France), Epidaure Center Val D'Aurelle-Paul Lamarque (Montpellier, France), and the International Confederation of Childhood Cancer Parent Organisations (ICCCPO; Nieuwegein, Netherlands). The programme's purpose is to fund promising projects in paediatric-cancer control in selected low-income and mid-income countries. 14 proposed projects in ten countries<sup>10,11</sup> were selected for funding. Project selection was based on five main points: feasibility, potential benefits for the community, sustainability, possibility for serving as a model for other countries, and accountability.<sup>10</sup> Substantial weight was given to the accountability criterion to avoid potential mismanagement of funds. We aimed to survey the current status of paediatric oncology care in the ten countries to obtain baseline data. Here we describe the status of paediatric-cancer care and the correlates of survival in these countries.

## Methods

### Procedures

In the absence of more reliable data sources, the status of paediatric oncology in Bangladesh, Egypt, Honduras, Morocco, the Philippines, Senegal, Tanzania, Ukraine, Venezuela, and Vietnam was assessed by a field survey. Population-based incidence estimates were used for comparison with survey data. No information from the application or selection process was used.

### Field survey

Between Sept 5, 2005, and May 26, 2006, interviews and data analysis were done by seven employees of Sanisphere (Neuilly-sur-Seine, France), a research company who specialise in public health, international affairs, project and health-services management, business, international health-care development, and public management (webtable). The data were extensively reviewed by the My Child Matters steering committee,<sup>10</sup> comprising mainly medical and paediatric oncologists with extensive international experience. Survey data are shown in tables 1 and 2.

First, each country was visited for 3 weeks between Sept 5, 2005, and May 26, 2006, by three Sanisphere employees (webtable). The survey comprised qualitative face-to-face interviews with oncologists of paediatric and adult cancers, family doctors, nurses, pharmacists, hospital managers, cancer-registry employees, government health officials, embassy employees, and representatives of international and local non-governmental and religious agencies (table 1). No standard forms were used, but a set of basic questions were asked in all interviews, including the estimated number of children at each step of the paediatric cancer-care chain, the number and description of paediatric-oncology units, the number of beds available for paediatric oncology, and the number of paediatric oncologists and nurses. The main purpose of the survey was to ascertain the availability of national paediatric-cancer programmes, dedicated paediatric-cancer hospital units, diagnostic resources, regular supplies of antineoplastic and antibiotic drugs, radiotherapy facilities, treatment guidelines or protocols, palliative-care programmes, parent support or advocacy organisations, paediatric oncology or haematology societies, and international partners.

	Centres visited, n	Total individuals interviewed, n	Physicians*			Cancer foundation representatives, n	Ministry of Health officials, n	Other, n†
			Paediatric haematologists or oncologists, n	Hospital or programme directors, n	Other, n			
Bangladesh	11	17	2	6	3	4	0	2
Egypt	12	37	18	12	2	0	1	4
Honduras	5	23	4	5	2	4	1	7
Morocco	10	35	5	8	7	3	2	10
Philippines	12	29	9	5	2	7	3	3
Senegal	9	32	1	2	11	2	4	12
Tanzania	8	19	0	6	9	0	1	3
Ukraine	14	21	11	13	0	0	0	1
Venezuela	7	32	14	6	0	5	1	7
Vietnam	13	37	7	21	0	1	5	3

\*Physicians might be listed in more than one category. †Social workers, pharmacists, and psychologists.

**Table 1: Number of centres visited and individuals interviewed by Sanisphere in the ten surveyed countries**

	Paediatric cancer units, n	Dedicated paediatric oncology beds, n	Paediatric oncology or haematology specialists, n	Availability of diagnostic services	Availability of medication, radiotherapy, blood products	Uniform treatment guidelines	Patients seen by health-care providers annually, n	Postulated 5-year survival (%)*
Bangladesh	2 in the capital	50	2	Poor	Poor	Poor	1000–1500	5
Egypt	20 across the country	350	100	Limited to adequate	Adequate	Limited	2300	40
Honduras	2 in two large cities	35	5	Limited	Limited	Limited	250	40
Morocco	3 in three large cities	35	15	Limited	Limited	Limited	750–800	30
Philippines	0	75	100	Poor to limited	Limited	Poor	1000	10
Senegal	In development	NA	1	Poor	Poor	Poor	100	5
Tanzania	1	20	0	Poor	Poor	Poor	400–450	10
Ukraine	30 (in all administrative regions)	NA	250	Adequate	Adequate	Adequate	1000	50
Venezuela	20 in large cities	100	35	Adequate	Adequate	Limited	1000	60
Vietnam	2 in two large cities	200–300	12	Poor to limited	Poor to limited	Poor	1000	5

NA=not available. \*All data were based on direct interviews done by Sanisphere with local health-care providers.

**Table 2: Field survey of paediatric-oncology status in the ten surveyed countries**

Diagnostic resources were classified by the interviewers as poor, limited, or adequate on the basis of timely access to the minimum necessary diagnostic procedures. Poor access was defined as nonexistent or unavailable access for most children with cancer; limited access was defined as inconsistent access or a long wait for results; and adequate access was defined as basic, timely diagnostic procedures available for most children. Availability of medications, blood products, and radiotherapy was deemed poor if they were unavailable to all or most children with cancer; limited if their availability was irregular; and adequate if they were available for most children in a timely manner.

The minimum requirement for diagnosis of solid tumours was histological assessment of haematoxylin and eosin-stained tumour sections. For diagnosis of leukaemia, assessment of a bone-marrow smear with Wright-Giemsa and myeloperoxidase staining was needed. Staging of solid tumours had to have been done by ultrasonography and CT. Minimum diagnostic resources for all cancers included the necessary medical expertise to interpret the diagnostic studies. The consistent availability (ie, accessibility to all or most patients) of pain control, psychosocial support, chemotherapy drugs, blood products, and antimicrobial drugs overall was classified as adequate or inadequate by the interviewers.

#### *Estimation of paediatric-cancer incidence*

The interviewers estimated the number of patients seen by each country's medical services on the basis of interview data from health-care providers and hospital-based registries. To assess the survey data, we used incidence data for each country obtained from existing, internationally reviewed, population-based cancer registries within that country or region for various time periods between 1982 and 2002.<sup>1,12–15</sup> Incidence data for Egypt,<sup>14</sup> the Philippines,<sup>14</sup> and Vietnam<sup>12,13,15</sup> were obtained from

regional population-based cancer registries. Incidence data for the remaining countries were obtained from cancer registries in neighbouring countries. The assumptions underlying the choice of surrogate population-based registries have been described elsewhere.<sup>13</sup> Briefly, surrogate countries were chosen on the basis of location adjacent to the country of interest, availability of population-based cancer data, and similarity to the reference population.

#### *Postulated survival of paediatric cancer*

Postulated survival in each country was derived from all available interview data. It was not possible to meet the criteria for standard statistical methodology because of great variation in the data sources and settings, and the scarcity of population-based or hospital-based registries. When consistent survival estimates were obtained from different sources in a country, the mean was calculated. When the estimates were inconsistent, more weight was given to sources closest to the clinical management of childhood cancer, unless their estimates differed substantially from all others. For example, in Morocco, 750–800 patients were seen annually (table 2), and all but 20 patients were treated in hospitals with cancer registries. We therefore based the postulated survival on the survival information derived from these cancer registries (about 300–350 survivors) together with the about 1000 new cases per year estimated from incidence data (table 3), arriving at about 30% survival. Because of the absence of systematic follow-up, postulated survival represents only short-term survival and might be overestimated.

#### *Demographic, health, and socioeconomic data*

For comparison and analytical purposes, we obtained data for each country from various sources. Government annual health-care expenditure per capita and number of

	Current estimated population <15 years of age <sup>16</sup>	Current estimated annual incidence of paediatric cancer (age <15 years)				Projected population <15 years of age in 2025 <sup>16</sup>	Projected annual number of new cancer cases in paediatric population (age <15 years) in 2025	
		Data collection period for reference rate	Reference (data sources, method of estimation)	Incidence (per million)	Cases, n		At current estimated population-based incidence per million	At European incidence (140 per million) <sup>17</sup>
Bangladesh	47 759	1982–92	12, 13	82	3916	61 314	5028	8584
Egypt	25 589	1999–2002	14	125	3199	26 062	3258	3649
Honduras	2699	1982–92	12, 13	130	351	2906	378	407
Morocco	10 499	1993–99	1	97	1018	10 413	1010	1458
Philippines	31 125	1998–2002	14	115	3579	32 698	3760	4578
Senegal	5016	1995–99	1	59	296	6717	396	940
Tanzania	16 174	1992–95	12, 13	134	2167	19 946	2673	2792
Ukraine	6863	1990–98	13, 24	135	927	5677	766	795
Venezuela	7578	1982–92	12, 13	134	1015	7206	966	1009
Vietnam	23 278	1991–97	12, 13, 15	117	2724	20 833	2852	3412

Table 3: Estimated current and future paediatric-cancer burden in the ten surveyed countries

physicians and nurses per thousand in 2006 were obtained from WHO,<sup>18</sup> and mortality data in patients aged under 5 years and per capita gross national income (GNI) in 2006 were obtained from the United Nations Children's Fund (UNICEF).<sup>19</sup> 2005 human development and human poverty indices were obtained from the UN Development Programme (UNDP).<sup>20</sup> The human development index, a composite, normalised measure of life expectancy, literacy, education, standard of living, and gross domestic product (GDP) per capita, is a standard measure of well being, especially child welfare, for countries worldwide. The human poverty index is a composite index that measures deprivation in three basic dimensions: a long and healthy life, knowledge, and standard of living. The statistical procedures used to derive these indices have been described elsewhere.<sup>21</sup> 2005 per capita GDP was obtained from the International Monetary Fund;<sup>22</sup> the 2006 total population and population under 15 years of age were obtained from the US Census Bureau;<sup>16</sup> and reports on childhood-cancer survival were obtained from European<sup>23</sup> and US<sup>24</sup> cancer registry data. We studied the correlation of these parameters, including incidence of paediatric cancer, survival, and access to care, with data obtained from the field surveys.

### Statistical analysis

The correlation between postulated childhood-cancer survival in the ten countries overall and demographic, health, and socioeconomic data was calculated as the Pearson's correlation coefficient ( $r$ ) and Pearson's coefficient ( $r^2$ ) by use of SAS (version 9.1). Logistic regression models were used to ascertain the correlation between combinations of predictive variables and postulated cancer survival. A corresponding probability value of 0.05 or less was deemed to show a significant correlation. Because the incidence of paediatric cancer is expected to increase as mortality from diseases of

poverty decreases in most of the ten surveyed countries, we also estimated the future annual incidence of paediatric cancer in these countries by assuming that it will equal current European incidence (140 cases per million)<sup>17</sup> by 2025.

### Role of the funding source

The sponsors of the My Child Matters programme (Sanofi-Aventis and UICC) had no role in the study concept, design, or in the collection, analysis, or interpretation of the data. The sponsors contracted Sanisphere to undertake a field study to ascertain baseline data on the countries chosen to receive My Child Matters grants. After Sanisphere employees presented the data to the My Child Matters steering committee, the authors analysed the data further and prepared the report. The steering committee members did not receive honoraria from UICC or Sanofi-Aventis for this activity. The authors were responsible for the concept, design, and the data analysis and preparation of the report. All authors had access to all the data in the study. RCR had the final decision to submit for publication.

### Results

Table 2 summarises the findings of the field survey and table 3 shows the number of current and future cases of paediatric cancer estimated from population-based data. A comparison of these two tables shows a marked discrepancy between the number of patients seen by health-care providers and the number of cases expected. In Bangladesh, the Philippines, Tanzania, and Vietnam, only about 15–37% of expected cases would have been seen by health-care providers, suggesting insufficient access to appropriate care. Only Ukraine had a national paediatric-oncology programme.

The number of paediatric-cancer units varied substantially between the countries. This essential component of modern paediatric oncology<sup>25</sup> was unavailable in the

	Total population (×1000) <sup>16</sup>	Physicians per 1000 population <sup>*18</sup>	Nurses per 1000 population <sup>18</sup>	Mortality in patients aged <5 years (per 1000) <sup>19</sup>	Per capita GDP (US\$) <sup>22</sup>	Total per capita health-care expenditure (US\$) <sup>18</sup>	Per capita government health- care expenditure (US\$) <sup>18</sup>	Human development index <sup>20</sup>	Human poverty index <sup>20</sup>
Bangladesh	144 320	NA	0.14	73	400	13	4	0.53	44.2
Egypt	77 506	0.54	2	33	1265	55	24	0.70	20
Honduras	7168	0.57	1.29	40	1148	72	41	0.68	17.2
Morocco	32 760	0.51	0.78	40	1713	72	24	0.64	33.4
Philippines	87 857	0.58	1.69	33	1168	31	14	0.76	15.3
Senegal	11 860	0.06	0.32	136	738	29	12	0.46	44
Tanzania	36 766	0.02	0.37	122	336	12	7	0.43	36
Ukraine	46 959	2.95	7.62	17	1766	60	40	0.77	NA
Venezuela	25 375	1.94	NA	21	5026	146	65	0.78	8.8
Vietnam	85 536	0.53	0.56	19	618	26	7	0.71	15.7

GDP=gross domestic product. NA=not available. \*Refers to all physicians.

**Table 4: Demographic, economic, and health indicators in the ten surveyed countries**

Philippines and Senegal. In Senegal, a unit with beds used for the treatment of Burkitt's lymphoma, acute lymphoblastic leukaemia, Wilms' tumour, Hodgkin's lymphoma, and retinoblastoma has since been established in partnership with the French–African Paediatric Oncology Group. Seven countries had too few paediatric-cancer units or beds (or both) to accommodate all paediatric-cancer referrals. Only Egypt, Ukraine, and Venezuela seemed to have adequate numbers of paediatric-cancer units and beds.

Tanzania had no formally trained paediatric haematologists or oncologists. Paediatric cancer was managed in the single Tanzanian paediatric-cancer unit (public) by a clinician assisted by radiation oncologists; in the other hospitals, public or private, paediatric cancer was mainly managed by paediatricians or family doctors. By contrast, Ukraine had 250 paediatric haematologists or oncologists (one specialist for every four incident cases). These ratios were 1:10 in the Philippines, 1:23 in Egypt, and 1:28 in Venezuela, which are considered adequate.<sup>25</sup> The remaining countries had ratios of 1:50 to 1:750, which are clearly inadequate for proper cancer care. Data from WHO suggested a median of 0.55 physicians of any type per 1000 population in the surveyed countries (range 0.06 in Senegal to 2.95 in Ukraine) and a median of 0.56 nurses (range 0.14 in Bangladesh to 7.62 in Ukraine; table 4).

Availability of diagnostic testing was poor or limited in eight of the ten countries, in which there was typically no expertise in the histological diagnosis of paediatric cancers, no consistent supply of immuno-histochemical reagents, long delays for pathology reports (as long as 1 month in Tanzania), or limited access to modern imaging or to other diagnostic technologies (or both). Modern diagnostic technology and access to it were adequate only in Ukraine and Venezuela. In Egypt, Honduras, Morocco, and the Philippines, diagnostic resources were available, but

	Pearson's correlation coefficient (r)	Pearson's r <sup>2</sup>	p
Government annual health-care expenditure per capita	0.939	0.882	<0.0001
Total annual health-care expenditure per capita	0.872	0.760	0.001
Per capita GDP	0.777	0.603	0.008
Per capita GNI	0.756	0.572	0.011
Physicians per 1000 population	0.749	0.560	0.013
Nurses per 1000 population	0.712	0.506	0.032
Human development index	0.631	0.398	0.050
Human poverty index	-0.593	0.351	0.093
Mortality in patients aged <5 years	-0.577	0.333	0.081

GDP=gross domestic product. GNI=gross national income.

**Table 5: Correlation of health and economic indicators with postulated 5-year survival of paediatric cancer in the ten surveyed countries**

were inaccessible to most patients living outside of the countries' largest cities.

Overall management of paediatric cancer and availability of medication, radiotherapy, and blood products was deemed poor or limited in seven countries. Only in Egypt, Ukraine, and Venezuela did most children diagnosed with cancer have access to anticancer drugs, antibiotics, blood products, and radiotherapy. Uniform treatment guidelines were absent in all countries except Ukraine, which uses national guidelines based on international protocols.

Postulated 5-year survival (table 2) was 5% to 10% in Bangladesh, the Philippines, Senegal, Tanzania, and Vietnam; 30% in Morocco; and 40% to 60% in Egypt, Honduras, Ukraine, and Venezuela. Demographic, economic, and health-care indicators relevant to population health also varied widely between all the countries (table 4). Several of these indicators were

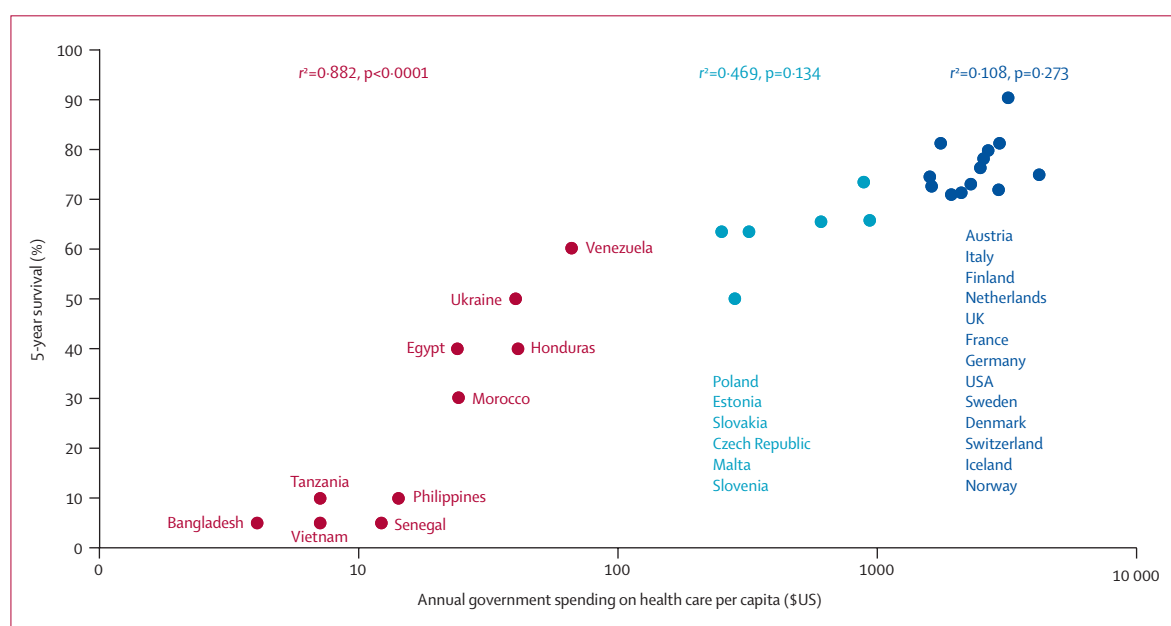
	Pearson's correlation coefficient (r)	Pearson's $r^2$	p
<b>Cancer units, beds, and patients, n</b>			
Paediatric-cancer units per 1000 children* in the population	0.78	0.62	0.007
Paediatric-cancer units	0.80	0.64	0.006
Dedicated paediatric-oncology beds per 1000 children in the population	0.71	0.50	0.05
Dedicated paediatric oncology beds	0.12	0.01	0.78
Cases seen by health-care providers annually per 1000 children in the population	0.96	0.93	<0.0001
Cases seen by health-care providers annually	0.25	0.06	0.49
<b>Employees, n</b>			
Paediatric oncology or haematology specialists per 1000 children in the population	0.51	0.26	0.13
Paediatric oncology or haematology specialists per child seen by health-care providers annually	0.44	0.19	0.21
Paediatric oncology or haematology specialists	0.47	0.22	0.17
<b>Diagnostics and therapeutics</b>			
Availability of diagnostic services	0.95	0.90	<0.0001
Availability of medications, radiotherapy, blood products	0.89	0.80	0.0005
Uniform treatment guidelines	0.88	0.78	0.0007

\*Aged under 15 years.

**Table 6: Correlation between paediatric-oncology care infrastructure and postulated survival**

significantly correlated with postulated survival in all the countries overall: per capita annual government health-care expenditure, per capita annual total health-care expenditure, per capita GDP, per capita GNI, and number of physicians and nurses per 1000 population (table 5). Annual government health-care expenditure per capita was most highly correlated with postulated survival in the countries overall ( $r^2=0.882$ ;  $p<0.0001$ ). This indicator was a better predictor of postulated survival than any other demographic, economic, or health indicator, and a better predictor than any combination of these variables (data not shown). Mortality in patients aged under 5 years, deemed a standard measure of children's health, was not correlated with postulated paediatric cancer survival ( $r^2=0.333$ ;  $p=0.081$ ). Surprisingly, the human development index ( $r^2=0.398$ ;  $p=0.050$ ) and human poverty index ( $r^2=0.351$ ;  $p=0.093$ ), which are commonly used to rank countries' economic performance, were also not correlated with postulated survival. We also studied the correlation between the findings of the field survey (table 1) and postulated 5-year survival. As expected, indicators suggestive of the availability of paediatric-cancer services were correlated with postulated survival (table 6).

We then compared the correlation of annual government health-care expenditure per capita with the estimated survival rates of children with cancer in all ten countries, 18 European countries,<sup>23</sup> and the USA<sup>24</sup> (figure). The correlation was strongest at the low end of the expenditure range ( $r^2=0.882$ ;  $p<0.0001$  for expenditures <US\$100) and weakest at the high end ( $r^2=0.10$ ;  $p=0.27$  for expenditures >US\$1000).



**Figure: Pearson's correlation between annual government health-care expenditure (US\$) per capita and childhood-cancer survival**

5-year survival data were postulated for the ten low-income and mid-income countries surveyed in this study; the remaining data were obtained from EUROCARE.<sup>23</sup>



## Discussion

Data from our field survey have shown that the postulated overall survival of children with cancer is dismal in Bangladesh, the Philippines, Senegal, Tanzania, and Vietnam, but is much better in Ukraine and Venezuela. Egypt, Honduras, and Morocco rank between these two groups. Postulated survival in the ten countries was significantly correlated with several socioeconomic and health-related indices established by international agencies, including total annual health-care expenditure, per capita GDP, per capita GNI, and the number of physicians and nurses per 1000 population; however, only annual government health-care spending per capita was independently correlated. Future research should focus on specific characteristics of public-health infrastructure represented by these expenditures and how they are associated with childhood-cancer survival.

Importantly, we noted that per capita annual health-care expenditure was significantly associated with childhood-cancer survival only in the lowest expenditure range. Not surprisingly, survival data were most favourable in countries where children are promptly referred to well-equipped tertiary-care centres. However, about 25–30% of patients are not successfully treated, even with optimum treatment. Therefore, once access to early diagnosis and adequate care (with the requisite hospital infrastructure) are available, additional investment of public-health resources has a smaller beneficial effect on survival. Because childhood cancer has a low overall incidence and most patients can be managed without complex infrastructure or procedures, a relatively small investment by governments or private sectors in conjunction with local organisations might make a large difference in survival in low-income and mid-income countries.

The absence of correlation between mortality in patients aged under 5 years and postulated survival was not surprising; this disparity has been seen in many low-income and mid-income countries.<sup>26–28</sup> We made this comparison because global health agencies deem mortality in patients aged under 5 years an important indicator of children's health. However, paediatric cancer is not a factor in mortality in this age group because of its relative rarity and its underdiagnosis in many countries. For example, even if all childhood cancer in Senegal were cured, Senegal's mortality in patients aged under 5 years would diminish only negligibly. Therefore, assistance or advocacy, or both, for treatment of paediatric cancer is unlikely to come from agencies that focus on child health in general. The relatively low mortality in this age group in some surveyed countries with poor postulated cancer survival suggests they have adequate basic public-health measures, but the economic, professional, technological, and infrastructure resources needed for effective management of childhood cancer remain

unavailable; abandonment of therapy is also likely to be a factor.<sup>29,30</sup>

Our study was substantially affected by a scarcity of population-based or even hospital-based cancer registries in most of the countries surveyed. Egypt, the Philippines, and Vietnam have regional population-based cancer registries that provide data for international comparative studies.<sup>12,14</sup> Ukraine has an established national population-based cancer registry, although its data has not been reviewed internationally. The estimated incidence of childhood cancer in Ukraine (based on reliable data from surrounding countries) is 135 per million person-years,<sup>13</sup> and our survey data yielded a postulated overall survival of about 50%. These estimates differ slightly from those reported by the Ukrainian national population-based registry<sup>31</sup> (incidence 120 per million person-years, and mortality 46 per million person-years in children aged under 15 years). However, under the crude assumption that mortality=incidence  $\times$  (1–survival), the Ukraine national population-based registry would predict overall survival as 62%. Because there is an estimated 20% proportion of under-reporting to the Ukraine national population-based registry, the survey data are not inconsistent with this survival prediction.

Our study had some limitations. We used incidence data estimated from reliable (although not necessarily representative) sources in or outside of the ten countries. Use of incidence data from surrogate countries is not an ideal method of estimation, but yielded the best available approximation (equally likely to deviate from the true incidence in either direction). The probability of 5-year survival was estimated by interviewing clinicians who directly cared for children with cancer, but who do not usually provide long-term follow-up. We should also acknowledge that low-income and mid-income countries can undergo rapid changes in health, demographic, and economic measures, especially during war or natural disaster, although to our knowledge there were no substantial changes in the surveyed countries during the study. Despite the possibility that our data are incomplete and biased, they provide the only currently available means of defining a baseline for use in assessing future progress.

Improvement of paediatric-cancer survival in low-income and mid-income countries might need alliances that combine government, public and private sectors, and medical societies.<sup>7</sup> Chile provides a remarkable example of what can be accomplished. Paediatric-oncology care in Chile has improved substantially over the past two decades through a strong alliance between the public and private sectors, and through the oversight of the Chilean Ministry of Health.<sup>32,33</sup> Honduras and Morocco, which have relatively high mortality in children aged under 5 years, have also made substantial progress in the past few years, including expansion of access to care, improvement of supportive care and

diagnostic capabilities, decrease of therapy abandonment and late diagnosis, and establishment of uniform treatment guidelines adapted to local resources. This progress has been helped by use of twinning programmes with St Jude Children's Research Hospital and by Morocco's participation in the French–African Paediatric Oncology Group.<sup>5,29,34,35</sup> The Honduran and Moroccan institutions have also created local non-governmental organisations that provide psychosocial and financial support to patients' families. Such organisations also work to increase awareness that paediatric cancer is curable, enlist community leaders, and campaign for national paediatric-cancer programmes. Most importantly, their fundraising activities sustain these programmes.

Twinning programmes enable rapid and relatively inexpensive improvement of survival of childhood cancer even in countries without optimum medical infrastructure and public-health funds. In countries where mortality in children aged under 5 years is relatively low, but where overall childhood-cancer survival is very poor—such as the Philippines, Vietnam, and many others—effective twinning programmes might prompt rapid progress. Paediatric-oncology units implemented and maintained through such programmes also promote national, regional, and international alliances, as exemplified in Honduras, Morocco, and other countries. As countries develop economically and can increase their investment in health care, the beneficial effect of twinning programmes will probably decrease.

A major challenge for the My Child Matters programme is the long-term sustainability of funded projects in paediatric oncology. Sustainability is an especially crucial consideration in countries such as Tanzania, Senegal, Vietnam, and the Philippines, which have many competing needs and few resources. One or more twinning sites in these countries, once established, might rapidly incorporate modern paediatric-cancer care. These centres could then serve as training sites for additional health-care providers and as community education resources. Eventually, regional collaboration and the participation of government and private agencies could expand access to a national level.

In summary, detailed surveys can provide useful data for baseline assessment of the status of paediatric oncology, but cannot substitute for national cancer registration. We suggest that paediatric-oncology registration in low-income and mid-income countries begin with the setting up of hospital-based registries,<sup>36</sup> although population-based registrations are the ultimate aim. Development of strategies to sustain and expand the successful funded projects remains a daunting challenge.

#### Contributors

RCR and FC were responsible for the study concept and design. TM collected and assembled the data. RCR, TM, ES-F, and SCH analysed

and interpreted the data. RCR, TM, and ES-F wrote the report. All authors revised and approved the final report.

#### Conflicts of interest

IT-F and CF are employed by Sanofi-Aventis. The other authors declared no conflicts of interest.

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