SA Journal of Oncology
ISSN: (Online) 2523-0646, (Print) 2518-8704

The University of Cape Town's paediatric cancer database: Results from the first years (2019–2021)

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Research Project Registration:
Project Number: 471010

Background: The paediatric oncology multidisciplinary team at the University of Cape Town (UCT) developed a research-ready data set.

Aim: This study aimed to describe the early results detailing the epidemiological profile of childhood cancer patients and evaluated factors associated with presentation and outcome.

Setting: The UCT paediatric oncology platform at the Red Cross War Memorial Children's Hospital (RCWMCH) and Groote Schuur Hospital (GSH).

Methods: A REDCap database was developed with a Cancer Association of South Africa (CANSA) grant. A database administrator consented all new patients and recorded demographic and social information.

Results: There were 212 children consented from 2019 to 2021: 109 girls and 103 boys. The age range was from 1 day to 15.98 years, with a median of 5.18 years. Only 32 (15%) of these families had medical insurance, 34 (16%) lived in informal housing and 25 (12%) did not have access to piped water. Seventy-four families (35%) reported a relative with cancer, including seven first degree relatives. With a median follow-up of 12.4 months, the estimated 2-year overall survival (OS) and event-free survival (EFS) was 77% and 72%, respectively. Overall survival was significantly different ($p = 0.013$) by disease group, varying from 100% for Wilms tumour and germ cell tumours to 52% for rhabdomyosarcoma. Most patients with solid tumours (72%) had advanced disease at diagnosis. Outcomes were poorer for children living in informal housing and without piped water.

Conclusion: A real-time database can provide a research-ready data set for interrogating cohort-specific factors impacting childhood cancer outcomes.

Keywords: paediatric oncology; cancer registry; childhood cancer incidents; childhood cancer outcomes; childhood cancer diagnoses; cohort-specific factor; socio-economic determinants of health; genetic determinants of health.

Introduction

Childhood cancer is an important public health issue. Approximately, 429 000 children worldwide develop cancer annually.[1] Of these, 80% live in low- and middle-income countries (LMICs)[2,3] with substantial regional inequality in childhood cancer survival. The success in high-income countries (HICs) is largely attributed to integration of care and research,[4] but in LMIC, mortality rates remain high with up to 80% of children dying of potentially curable disease because of limited access to care, late diagnosis, co-morbidities and toxicity.[1,5] A key barrier to improving these outcomes is the lack of accurate, population-based data from LMICs on childhood cancer incidence, stage at diagnosis and survival.[6]

According to the Cancer Atlas, only 5.3% of childhood cancer in Africa is registered (compared with 66.0% in Europe and 97.0% in the United States of America)[7] (see Figure 1). Registries assist by tracking the incidence of cancers, assessing the extent and severity of disease at diagnosis and allowing the evaluation of outcomes and the development of research goals.

There are several barriers to implementation of childhood cancer-specific registries.[8] Whilst paediatric cancers are more curable than adult cancers, they form a very small percentage of

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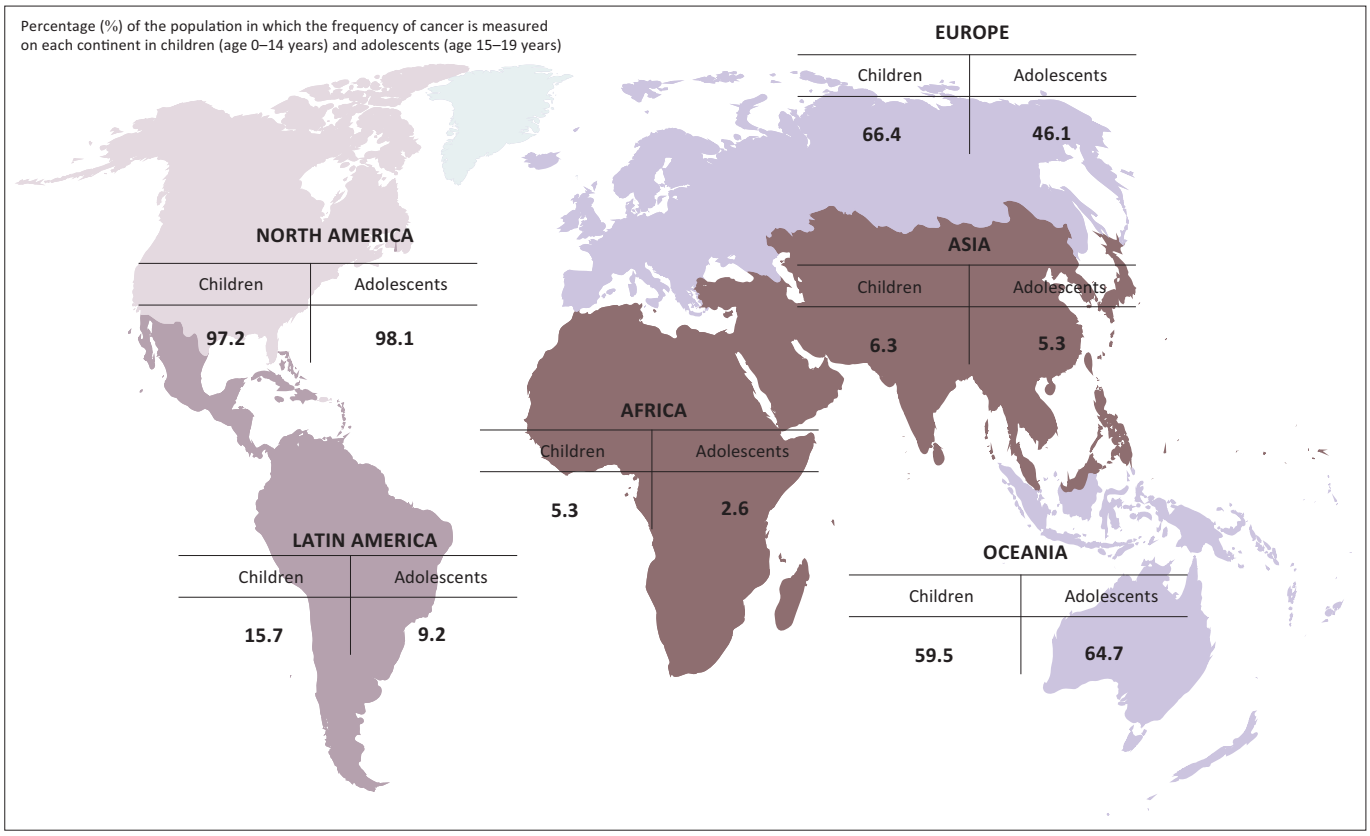
Dates: Received: 12 Mar. 2022 | Accepted: 16 May 2022 | Published: 24 Aug. 2022

How to cite this article: Davidson A, Moodley J, Pillay K, Hendricks M, Stewart A, Parkes J. The University of Cape Town's paediatric cancer database: Results from the first years (2019–2021). S. Afr. j. oncol. 2022;6(0), a234. https://doi.org/10.4102/sajo.v6i0.234

Note: Additional supporting information may be found in the online version of this article as Online Appendix 1.



Source: Steliarova-Foucher E. Cancer in children. In: Jemal A, Torre L, Soerjomataram, Bray F, editors. The cancer atlas. 3rd ed. Atlanta, GA: American Cancer Society, 2019; p. 42. Available from: www.cancer.org/canceratlas

FIGURE 1: The Cancer Atlas 2019: Childhood and adolescent coverage worldwide.

overall cases.[9] Despite the recognised value of cancer registries and databases,[3,4,5] funding and maintenance of such registries is difficult, especially in LMIC.[10,11] Hospital-based cancer registries (HBCRs) provide readily accessible information on patients with cancer, the treatment received and the outcomes. Specialised registries collect and maintain data on particular types of cancer and population-based cancer registries (PBCRs) collect data on all new cases of cancer occurring in a well-defined population.[12] As the most important form of PBCR, national cancer registries provide an invaluable resource of information for policy formulation and research.[13]

The South African Children's Tumour Registry was started in 1987 as an initiative of the South African Children's Cancer Study Group and is the main source of statistical data on paediatric cancer in South Africa.[13] This registry receives data from all the major paediatric oncology centres in the country and the data collected include tumour type, basic socio-demographic information, stage and outcome of malignancies. Whilst this information is valuable, it is limited by a lack of detailed clinical, risk factor and biological data.

The cause of most childhood cancers remains largely unknown. Variation in types of cancer by region could point to a unique gene–environment interaction.[14] In LMIC additional questions relate to feasible and affordable treatment strategies, late stage at presentation, interaction with infectious agents, impact of nutritional status, impact of human immunodeficiency virus (HIV), gene–environment interaction and disparities in access to care.[8,15,16,17]

The paediatric haematology–oncology service at Red Cross War Memorial Children's Hospital (RCWMCH), established in 1967, is one of South Africa's leading referral centres for blood diseases and cancer. Children up to 15 years of age are seen here whilst older children are managed at the adult oncology service at Groote Schuur Hospital (GSH). The unit that manages about 100 new cases of childhood malignancy and attracts approximately 1200 admissions and 4800 outpatient visits annually has treated over 5000 children since 1970. Of the 676 patients treated between 2011 and 2015, 538 are still alive, with a crude five-year survival rate of 80%.

Researchers and clinicians at the RCWMCH and GSH, who constitute the University of Cape Town (UCT) paediatric oncology complex, articulated the need for a research-ready data set during a 2013 situational analysis of cancer research. We therefore collaborated with the Cancer Research Initiative (CRI) in the Faculty of Health Sciences and the Clinical Research Centre (CRC) at UCT to design a questionnaire. Hospital-based cancer registries form an integral part of any PBCR and are easier to set up and believing that this platform would offer unique opportunities for integrated translational research, we obtained ethical approval for a REDCap-based registry (Human Research Ethics Committee [HREC] R046/2015). The project was entitled 'Responding to South

Africa's childhood cancer challenges: The RCCH/GSH/UCT paediatric cancer database'. A Cancer Association of South Africa (CANSA) research grant was awarded in 2017.

The primary aim of the database was to create a research-ready data set in REDCap with the ability to describe the epidemiological profile of our paediatric cancer patients and to determine factors associated with stage at presentation, progression, treatment response, survival and outcome. There were many secondary aims, including developing a platform to evaluate diagnostic and prognostic markers, training and mentoring new researchers and increasing clinician-researcher capacity.

This study aims to provide an analysis of data from the first three years (2019–2021) and to assess the utility of the database in terms of the primary and secondary aims.

Methods

A database questionnaire was designed by the clinicians at the RCWMCH and GSH, who constitute the University of Cape Town (UCT) paediatric oncology complex. This questionnaire was structured according to the aims outlined above. A selection of fields included in the database is shown in Table 1.

A REDCap database (PECAN Data Labels … Online Appendix 1) was developed from our data sheet by the UCT Clinical Research Centre and consent forms were developed in English and then translated into Afrikaans and Xhosa in 2019 (acknowledged by HREC in June 2019).

It is worth noting that at the outset we specified staging according to institutional or disease-specific protocols. Leukaemias were qualified as central nervous system (CNS) 1 or 3; Burkitt lymphomas were denoted by A, B or C according to the lymphomes malins B (LMB) protocol; medulloblastomas were described as M0 to M4 according to Chang; and rhabdomyosarcomas (RMS) 1–4 according to surgical grouping. All other tumours were staged 1 through 4 or 5 in the case of bilateral tumours.

A Xhosa-speaking database administrator was employed to obtain informed consent from the parent and/or guardian and collect relevant data using a structured questionnaire, patient records and a custom designed case report form. The administrator was trained to capture all data electronically by entering it onto the REDCap database using a tablet computer. The database administrator had experience in cancer research but required considerable training at the outset and ongoing supervision by the principal investigator.

A data management plan was developed to manage data cleaning, validity checks and quality assessment, provision of secure and confidential data storage, plans for data backup, security checks, password protection and controlled levels of access to the database. Quarterly reports on the status of data collection and a set of key variables are reported to the research and management teams.

All children under the age of 15 years presenting with a cancer (including CNS tumours of benign and uncertain behaviour) to the RCWMCH oncology unit between January 2019 and December 2021 were included following informed consent/assent of patients and legal guardians. Patient data were prospectively collected. Patient hospital folders, oncology folders, the radiology PACS database, the National Health Laboratory System (NHLS) TrakCare database for laboratory data and radiotherapy folders were used to collect relevant additional information to update records at each visit.

Clinical and pathological characteristics of the study participants are presented in the form of means, standard deviation, range and confidence interval (confidence interval [CI], 95%) for normally distributed variables and median, interquartile range and range for skewed variables. For categorical data such as gender, stage and performance status, we summarised the data as frequencies and presented it using histograms, pie charts, bar graphs, linear graphs and tables.

Statistical analysis was performed using Statistica™. Treatment outcomes in the form of overall survival (OS) and event-free survival (EFS) were represented as Kaplan–Meier curves. The log-rank test was used to compare two groups or two treatments, whilst the Chi-square test was used to compare more than two groups or two treatments. A probability value of less than 5% (0.05) was considered to be statistically significant using a 95% CI.

TABLE 1: Database fields.

Number	Fields
1	Patient name and hospital number
2	Caregiver contact details
3	Socio-demographic data including: • Place of birth • Current address • Gender • Medical aid membership • Type of housing • Availability of water and electricity at home
4	Family history of cancer
5	Symptom history • Initial symptoms (description and duration) • Pathway followed to healthcare
6	Clinical findings on admission including • Nutritional status • Stage at diagnosis • Metastatic involvement • Stage and histological sub-classification • Presence of comorbidities including TB and HIV
7	Diagnostic information • Pathology results • Imaging results
8	Therapeutic information • Date and type of surgery • Data on radiotherapy management • Data on chemotherapy management
9	Treatment outcomes • Remission • Relapse
10	Current status and date of each clinic visit

TB, tuberculosis; HIV, human immune deficiency virus.

The demographics and statistics were then compared with each of the primary and secondary aims to assess whether the aims of the database were being met.

Ethical considerations

Ethical approval to conduct the study was obtained from the Human Research Ethics Committee of the University of Cape Town (No.: 085/2022).

Results

A total of 212 children were included in the analysis. There were 109 girls and 103 boys, ranging in age from one day to 15.98 years (median 5.18 years). The girls (one day to 15.98 years, median age of 4.64 years) were younger than the boys (one day to 15.54 years) with a median of 5.47 years.

Most of the children lived in formal housing (178; 84%) and had access to electricity (207; 98%) and domestic piped water (187; 88%). Only 32 of these families (15%) had medical insurance. In terms of pathways of care, no family reported visiting a non-allopathic practitioner to the database administrator. Parents reported between 0 (20 patients presented directly to RCWMCH) and 21 visits to other health facilities, with a median of one visit. Twelve patients had 10 or more visits to other health facilities before being referred to RCWMCH. With respect to comorbidities, only four patients had HIV at diagnosis, one patient had nodal tuberculosis (TB) at diagnosis and one patient developed pulmonary TB on treatment.

In terms of genetic predisposition, 74 families (35%) reported a relative with cancer, including seven first degree relatives (one each from a known retinoblastoma family and a known DICER family) and one set of first cousins with the same diagnosis of acute myeloid leukaemia (AML). Incident cancers were in order of frequency: B-cell acute lymphoblastic leukaemia (ALL) (n = 14; 17%), Wilms tumour (n = 7; 9%), non-medulloblastoma CNS embryonal tumours (n = 4; 5%) and RMS (n = 4; 5%). Three children (4%) with retinoblastoma had relatives with cancer (one each with breast and cervical cancer and the retinoblastoma family referred to above) as did three children each with AML, Hodgkin's disease (HD), neuroblastoma and high-grade glioma. Associated cancers in order of frequency included breast cancer (n = 25; 34%), stomach cancer (n = 9; 12%), cervical cancer (n = 8; 11%), prostate cancer and thyroid cancer (both: n = 7; 9%). There were no specific or strong correlations between incident and associated cancers.

Leukaemia and lymphoma were the most frequently reported diagnostic groups (44%), followed by CNS tumours (14%) and sarcomas (9%) (Table 2). The most common primary site was bone marrow (33%), followed by abdomino-pelvic organs or soft tissue (26%) and the CNS (14%) (Table 3). Considering the small size of the data set and the need to compare the solid tumours we converted LMB stages into St Jude/Murphy and Chang into a standard 1–4 system for CNS tumours (1 = fully resected; 3 = irresectable; 4 = metastatic). On that basis the stage distribution for the solid tumours was as follows: stages 1–24 (17%), stages 2–11 (8%), stages 3–64 (45%), stages 4–38 (27%) and stages 5–5 (4%) (Table 2).

Diagnosis was made on imaging (all MRI) in 12 cases, bone marrow only in 76 cases, histology only in 109 cases and cytology only in seven cases (mostly renal tumours). Seven patients had positive bone marrow trephines documented at the time of surgery when they underwent definitive biopsy. Five of these patients had neuroblastoma and two had RMS.

Cytotoxic chemotherapy was given to 186 patients (88%) and sirolimus to two patients. All patients were treated with standard institutional protocols, two children with irresectable atypical teratoid rhabdoid tumours were palliated at the outset and the other 24 patients were treated with surgery and/or radiotherapy only.

A total of 81 (38%) patients had no surgery (including all but two of the patients with leukaemia). Importantly, the insertion of ports and lines was not coded in the registry. Seventy-nine patients had a diagnostic biopsy and 46 patients had upfront resection. Six patients with Wilms tumour had a percutaneous fine needle aspiration biopsy (FNAB) under conscious sedation. Thirty-five patients went on to have definitive resections after neoadjuvant chemotherapy and eight patients had additional neurosurgical procedures, including seven ventriculoperitoneal (VP) shunts and one Ommaya reservoir insertion.

Radiotherapy was administered to 58 (27%) patients for a variety of indications including leukaemia (n = 9; 16%), CNS tumours (n = 17; 29%), neuroblastoma (n = 5; 9%), Wilms tumour (n = 9; 16%) and sarcoma (n = 12; 21%). Three patients were treated with brachytherapy and one received radioactive iodine. Considering the 54 patients receiving external beam radiotherapy (EBRT), all were treated on a linear accelerator (Linear accelerator [LINAC]) and 3D planning was used for 20 patients and volumetric modulated arc therapy (VMAT) was used for 34 patients. Doses of 10–15 Gray were administered to 15 patients, doses up to 50 Gray were administered to 16 patients and doses exceeding 50 Gray were administered to 23 patients (43%). Only two patients suffered acute severe side effects. One had grades 3–4 mucositis and one had severe acute brain toxicity during radical RT for an anaplastic astrocytoma and had to have her RT discontinued.

At the end of the study period, with a median follow-up of 12.4 months, 173 patients (82%) patients were alive; 145 (68%) patients were alive and disease free and 28 (13%) patients were alive with disease, 34 patients (16%) had died (25 of disease, 6 of treatment-related causes and 3 of unrelated causes) and five (2%) patients had been lost to follow-up in remission. Two patients were palliated at the outset and seven patients experienced primary progression on treatment.

TABLE 2: Staging and outcomes data.

Diagnosis	Number of cases	Staging information								Survival	
		CNS 1	CNS 2	CNS 3	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	EFS (%)	OS (%)
Leukaemia	**70**										
ALL	46	30	15	1	-	-	-	-	-	77.2	78.4
AML	21	15	4	2	-	-	-	-	-	63.5‡	54.9‡
CML	3	NA	NA	NA	-	-	-	-	-	0.0	0.0
Solid tumours	**152**										
Lymphoma	**24**									95.8	95.5
Hodgkin	10	-	-	-	2	5	2	1	NA	88.9	88.9
Lymphoblastic	5	-	-	-	0	1	2	2	NA	100.0	100.0
Burkitt	9	-	-	-	1	0	2	6	NA	100.0	100.0
CNS†	**29**									62.1‡	60.2‡
Low-grade glioma	9	-	-	-	0	0	9	0	NA	75.0	75.0
High-grade glioma	6	-	-	-	0	0	6	0	NA	0.0	0.0
Medulloblastoma	5	-	-	-	2	0	0	3	NA	100.0	100.0
Other embryonal	7	-	-	-	5	0	0	2	NA	54.0	54.0
Other	2	-	-	-	0	0	1	0	NA	100.0	100.0
Neuroblastoma	**10**									66.7	88.9
Neuroblastoma and ganglioneuroblastoma	10	-	-	-	0	0	3	7	NA	66.7	88.9
Retinoblastoma	**8**									83.6‡	75‡
Retinoblastoma	8	-	-	-	4	1	0	0	3	83.6‡	75‡
Renal tumours	**14**									92.0	100.0
Wilms tumour	14	-	-	-	3	2	4	4	1	92.0	100.0
Liver tumours	**8**									57.2	85.8
Hepatoblastoma	8	-	-	-	0	0	6	2	NA	57.2	85.8
Bone tumours	**6**									30.0	50.2
Osteosarcoma	5	-	-	-	0	0	4	1	NA	30.0	50.0
Other	1	-	-	-	0	0	1	0	NA	100.0	100.0
Sarcoma	**20**									58.1	74.4
RMS	10	-	-	-	0	0	5	5	NA	25.8	51.4
NRSTS	10	-	-	-	0	0	9	1	NA	85.7	100.0
Germ cell tumour	**12**									90.1	100.0
MGCT	5	-	-	-	0	2	1	1	1§	100.0	100.0
Teratoma	7	-	-	-	4	0	3	0	NA	85.7	100.0
Carcinoma	**3**									100.0	100.0
Carcinomas	3	-	-	-	1	0	1	1	NA	100.0	100.0
Histiocytoses	**8**									100.0	100.0
LCH	3	-	-	-	1	0	1	1	NA	100.0	100.0
Other	5	-	-	-	1	0	3	1	NA	100.0	100.0

OS, overall survival; EFS, event-free survival; AML, acute myeloid leukaemia; CNS, central nervous system; ALL, acute lymphoblastic leukaemia; RMS, rhabdomyosarcoma; NA, not applicable; CML, chronic myeloid leukaemia; NRSTS, non-rhabdomyosarcoma soft tissue sarcoma; MGCT, malignant germ cell tumour; LCH, Langerhans cell histiocytosis.

†, For CNS tumours here: 1 = fully resected; 3 = irresectable; 4 = metastatic. ‡, Notably some of the event-free survival outcomes are better than the overall survival outcomes because of late events in small groups. §, This was a 2-week-old girl with bilateral juvenile granulosa cell tumours.

Twenty-nine patients (14%) relapsed but treatment at relapse was not captured.

The two-year estimated OS and EFS for the whole group was 76.9% and 71.9%, respectively. Overall survival and EFS for individual diagnostic groups and sub-groups are shown in Table 1. Notably some of the EFS outcomes are better than the OS outcomes because of late events in small groups. And whilst the statistical survival of the three patients with chronic myeloid leukaemias is 0.0% because of a late event, two of the three children remain alive with disease. The OS was significantly different (Chi-squared: $p = 0.01$) for the common childhood malignancies: ALL (78.1%), AML (54.9%), lymphoma (95.5%), CNS tumours (59.7%), neuroblastoma (88.9%), retinoblastoma (75.0%), Wilms tumour (100.0%), hepatoblastoma (85.8%), RMS (51.7%) and extra-cranial germ cell tumour (ECGCT) (100.0%) (Figure 1).

Outcomes in terms of EFS (53.0% vs 76.1%) and OS (60.9% vs 80.2%) were significantly poorer for children from families in informal housing (Log rank *p*-values of 0.008 and 0.039). For those without access to piped water, the outcomes were poorer (OS of 61.2% vs 78.6% with a Log rank *p*-value of 0.058) although this narrowly missed the threshold for statistical significance. Outcomes were not better for those with medical insurance. Children with a family history of malignancy showed a trend towards worse outcomes in terms of OS (64.1% vs 85.4% with a Log rank *p*-value of 0.09) but again this did not reach statistical significance. Importantly, the three common malignancies (AML, CNS

tumours and RMS) that performed poorly were equally represented in the whole group (28.0%) compared with those families in informal housing (35.0%) and without access to piped water (28.0%) but over-represented in children whose families had medical insurance (50.0%). This is largely because patients requiring more intensive regimens tend to be referred to RCWMCH. They were in turn under-represented (23.0%) amongst children from families who reported a history of cancer. Overall survival and EFS according to social determinants are shown in Table 4.

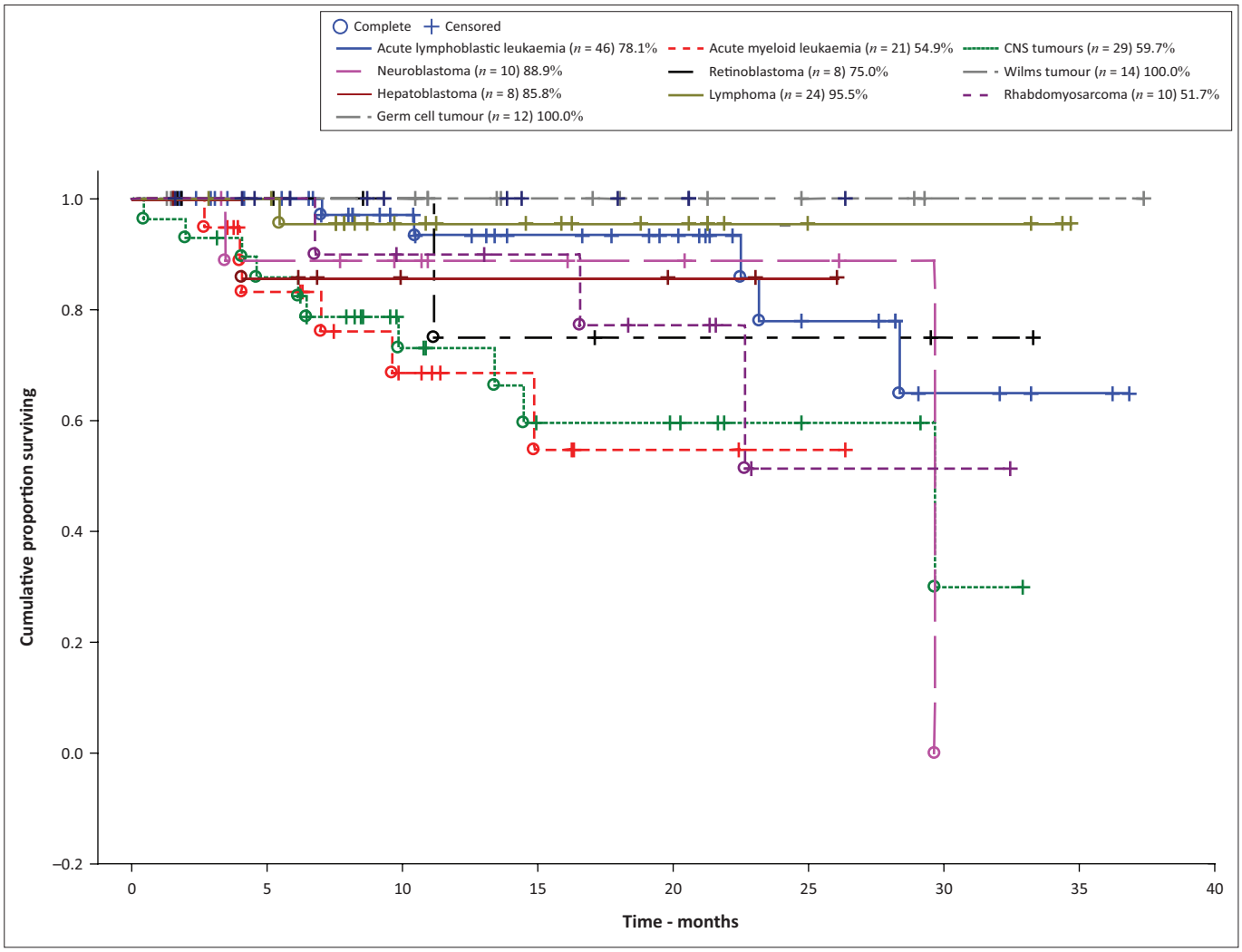
TABLE 3: Tumour site.

Tumour site	Number	Percentage
Abdomen, pelvis and retroperitoneum	12	6
Adrenal gland	9	4
Bone marrow	70	33
Bones	11	5
Brain and spinal cord	30	14
Eye	9	4
Kidney	14	7
Liver	9	4
Lung	2	1
Lymph nodes	21	10
Ovary	8	4
Skin	3	1
Soft tissues of the head and neck	7	3
Testis	4	2
Thymus	2	1
Thyroid gland	1	0

Discussion

Setting up this database proved to be a very worthwhile collaboration between the various services that look after children with cancer in the UCT complex. Discussing the fields to be incorporated into the questionnaire was an opportunity to interact and learn what data are important to various parts of a multidisciplinary team, which is recognised nationally and internationally for its ability to provide a high-quality clinical service. The database contains information that could be used by any member of the team, with appropriate permissions and ethical approval.

Although this was conceived as a comprehensive hospital-based registry, it has the makings of a limited population-based registry. All children under 15 years of age diagnosed with cancer in Cape Town's West Metropolitan region are



Note: Chi-square = 21.73; degree of freedom = 9; $p = 0.01$.

FIGURE 2: Two-year estimated overall survival by diagnosis.

TABLE 4: Survival according to social determinants of health.

Socioeconomic parameter	EFS (%)	Log rank *p*	OS (%)	Log rank *p*
Medical insurance?				
Yes (*n* = 32)	56.9	0.23	63.3	0.49
No (*n* = 180)	75.3		79.7	
Formal housing?				
Yes (*n* = 178)	76.1	0.008	80.2	0.039
No (*n* = 34)	53.0		60.9	
Electricity?				
Yes (*n* = 207)	71.7	0.47	76.6	0.58
No (*n* = 5)	100.0		100.0	
Piped water?				
Yes (*n* = 187)	72.8	0.22	78.6	0.058
No (*n* = 25)	65.9		61.2	
Visits prior to referral				
≥ 5 (*n* = 20)	93.7	0.1	93.7	0.23
< 5 (*n* = 192)	70.1		75.4	
Family history of cancer?				
Yes (*n* = 74)	60.5	0.15	64.1	0.09
No (138)	79.4		85.4	

treated under a combined state and private academic complex, which includes RCWMCH, GSH and a private practice at Cancercare at Rondebosch Medical Centre with the advantage of expert, team-based academic oversight irrespective of the patient's source of funding. If we were able to recruit all of these to the database, then we could regard our data set as being population-based.[18,19] Patients referred from outside the area for treatment would need to be excluded.

The major logistic hurdles we faced were the absolute cessation of activity during hard lockdown followed by a series of workplace restrictions related to UCT's coronavirus disease (COVID) regulations. As a result, our administrator was not free to travel and interact with new patients outside of our very tightly controlled clinical context, and we were not able to expand the footprint of the registry as we had hoped. These limitations have been well documented in the literature. The extended International Agency for Research on Cancer (IARC) team[20] has described the profound impact of COVID-19 on the three principal areas of cancer registry operations: staffing, financing and data collection. And ironically, because our HREC application was completed before the COVID-19 pandemic began, we were not able to document our COVID-19 experience in the same way as some cancer registries.[21]

Thus, it is logical that we add COVID-19 status to our set of fields, as well as the following data fields as we move forward: for patient demography and social determinants of health: underlying genetic syndromes such as trisomy 21 and maternal level of education; for the diagnostic fields: prognostic tumour-specific mutations such as NMyc and leukaemia-related recurrent translocations; for surgery: insertion of ports and lines and complications; for radiotherapy: focal versus craniospinal RT for CNS tumours; for chemotherapy: complications; and for outcomes: type of relapse, treatment at relapse and outcome of relapse treatment.

There were some expected findings with respect to social determinants of health and some novel findings with respect to family history of associated cancers amongst family members of patients reported on the registry. Children whose families lived in informal housing and had no access to piped water had the same profile of tumours as the whole group but did relatively poorly. Children whose families had a history of cancer had relatively fewer cancers associated with a poorer survival (AML, CNS tumours and RMS) compared with the whole group, but did relatively poorly as a group anyway. We hope to study these aspects in more detail in the future.

Compared with commonly reported childhood cancer data in the northern hemisphere, we reported relatively fewer CNS tumours (14%). Registry data from Ireland[22] and the United States[23] report CNS tumours as 27% of incident childhood cancer. This difference is likely because of the recruitment process as some children with CNS tumours are treated only with surgery and others are referred directly for radiotherapy after their surgery. These children did not present to the paediatric oncology unit at RCWMCH during this period, and therefore were not recruited to the database. We hope to remedy this by facilitating visits for all newly diagnosed paediatric cancer patients to the oncology unit at RCWMCH. This should be feasible now that the COVID-19 epidemic is more contained.

In 2011, Regulation no. 380 of the *National Health Act no. 61 of 2003* was created to make cancer a reportable disease in South Africa. All paediatric oncology units routinely supply information to both the National Cancer Registry (NCR) and the South African Children's Tumour Registry. At RCWMCH the paediatric cancer database (PCD) database administrator and the NCR registry curator work closely together. Database entries were cross-checked against the information submitted to the NCR to ensure reliability. The only notable difference is that some patients reported to the NCR were not consented and thus do not appear in the PCD. Based on SACTR data we estimate that about 30% of eligible patients were not consented for this registry. Conversely, the data supplied to NCR are very limited compared with that contained in the PCD.

Most of the children who had solid tumours (102% or 72%) presented with advanced disease (stage 3 or 4), including 38 of them (27%) with metastatic disease. Comparing such a spectrum of tumours with respect to the extent of disease is difficult and perhaps we need to look at the Toronto Childhood Cancer Stage Guidelines going forward?[24] Nonetheless, it is well described in the LMIC context that advanced presentations are associated with poorer survival.[6] Despite this, our early outcomes measured as estimated two-year OS were more than 75% for all major tumour groups, except AML, CNS tumours and RMS. We would expect that an estimated five-year OS will yield less favourable results as it is likely that some children will succumb to their disease with time.

Gathering and curating data of this complexity require a full-time data administrator. We were very gratified to receive support from CANSA. It is well recognised that despite their utility for service planning, research and advocacy, registries operate with substantial fixed costs,[25] and this poses an ongoing threat to sustainability. The struggle to fund operations, as in much of the LMIC oncology research paradigm, is an ongoing one.

We have achieved the primary aims of the database, which were to create a research-ready data set in REDCap and to describe the epidemiological profile of paediatric cancer patients, as well as to determine factors associated with stage at presentation, progression, treatment response, survival and outcome. However, the secondary aims of the database were too ambitious given the time frame. We trained and mentored our administrator and upskilled our National Cancer Registry curator and there was a small increase in clinician-researcher capacity as our administrator was able to assist one of the consultants with work on a PhD. Also, we would argue that this is now a research-ready platform for the study of diagnostic and prognostic markers. But only as we go forward will we be able to pursue factors associated with cancer progression, survival and treatment response, to develop evidence-based treatment and public policy recommendations and to consider whether current prevention and treatment strategies are cost-effective.

In the short to medium term, we anticipate that this resource will be used on demand for specific research studies by any member of our multidisciplinary team. We will need to acquire a larger data set before it is mature enough for that purpose. In addition, the database has the potential to provide the oncology team at the RCWMCH with annual data to report and assess local incidence, performance and outcomes.

Limitations

The main limitation of our study was our inability because of COVID-19-related restrictions to include children diagnosed in other units of the UCT complex. That is an ambition and intention going forward, and we would like to recruit patients attending the private service treating childhood cancer patients in the West Metro, which is based at the Rondebosch Medical Centre.

A consideration for the future is the lack of ongoing funding. Registries seeking to delineate comprehensive data take time to produce useful outputs with respect to determinants of disease and the success of treatment strategies as measured by survival. If we can overcome the funding hurdle, we may be able to add value into the future.

Conclusion

Active inclusion of children and families in a robust database maintained in real time can provide a research-ready platform for the multidisciplinary team and generate new areas for research.

Acknowledgements

The authors would like to thank CANSA for their valuable support and database administrator Lungiswa Nikani for her efforts.

Competing interests

The authors declare that they have no financial or personal relationships that may have inappropriately influenced them in writing this article.

Authors' contributions

A.D. was involved in database design and setup, data analysis, manuscript writing and editing. J.M. and K.P. were responsible for database design and manuscript editing. M.H. performed manuscript editing. A.S. was responsible for database design and setup. J.P. was involved in database design, manuscript writing and editing.

Funding information

This work was made possible by a Cancer Research Grant from the Cancer Association of South Africa.

Data availability

The primary data used in this study are available from the corresponding author, A.D., upon reasonable request.

Disclaimer

The views and opinions expressed in this article are those of the authors and do not necessarily reflect the official policy or position of any affiliated agency of the authors.

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