Incidence and survival of retinoblastoma in Taiwan: a nationwide population-based study 1998–2011

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ABSTRACT

Objective To study the epidemiology of retinoblastoma in Taiwan from 1998 to 2011.

Design This was a retrospective population-based cohort study using the Taiwan National Health Insurance Research Database.

Results The present study included 154 patients (92 males, 62 females) with retinoblastoma and the documented overall retinoblastoma incidence was 1 in 17 373 live births without a notable trend over the study period. The incidence per million live births examined by gender was 65.8 for males and 48.5 for females. The age-specific sex ratio increased from 1.4 at age younger than 1 year to 3.0 above age 4 years. Enucleation was performed in 109 (70.8%) children with retinoblastoma, and it was more prevalent in males than in females (77.2% vs 61.3%, p=0.0335). Multivariate Cox regression analyses with adjustment for diagnostic age, sex, and birth year elucidated that enucleation was a significant factor associated with survival (OR 0.27, 95% CI 0.10 to 0.61).

Conclusions The incidence of retinoblastoma in Taiwan exhibited no marked trend over time. There were more cases of males than females and the male-to-female rate ratio increased with age. Survival outcome was significantly associated with the intervention of enucleation.

INTRODUCTION

Retinoblastoma is the most frequent paediatric eye cancer. It is very aggressive and life-threatening if untreated, but it is curable if detected at an early stage.4 Early diagnosis and prompt treatment are vital for children with this devastating eye malignancy in order to preserve their life and sight.

Population-based studies of the epidemiology of retinoblastoma have been conducted in several countries, such as the USA,2,3 Great Britain,4 Europe,5 Singapore,6 Japan1 and Korea.8 The incidence rates of retinoblastoma ranged approximately 40–60 per million live births worldwide, which corresponds to 1 per 16 000–24 000 live births.2,3,4,9,10 Taiwan has reported an incidence of 1 per 21 691 live births during 1979–2003,10 but no updated information on retinoblastoma is available for the past decade. Additionally, survival rates for retinoblastoma vary among different countries and races. The overall 5-year survival is 83%–97% in some developed countries such as Great Britain,4 Mexico,10 Singapore9 and USA,11 but much lower (20%–48%) in developing countries such as Africa and India.12,13

Retinoblastoma management in the past decades aimed to save the life, eye, vision and cosmetics of the child, in order of priority. Current therapeutic measures for retinoblastoma include enucleation (eye removal), external beam radiotherapy, systemic chemotherapy for metastasis and chemoreduction with or without focal tumour consolidation using various focal therapies, such as thermotherapy, cryotherapy, laser photocoagulation and plaque radiotherapy.14–17 Recently, intra-arterial chemotherapy and intravitreal chemotherapy have evolved as impressively effective therapies for managing advanced and refractory retinoblastoma because of their ability to save globes which would have been enucleated.17–20 However, the modality of enucleation still remains a vital option for retinoblastoma treatment, especially for the eye with intraocular retinoblastoma of International Intraocular Retinoblastoma Classification (IIRC) group E.21 This study aimed to update the incidences of retinoblastoma in Taiwan between 1998 and 2011 using a nationwide population-based data set. We also investigated the survival of patients with retinoblastoma and its associated factors.

MATERIALS AND METHODS

Data sources

The data of this population-based study were obtained from the Taiwan’s National Health Insurance Research Database (NHIRD). Taiwan started a National Health Insurance (NHI) programme in 1995 that provides health care for more than 99% of the entire population. The NHIRD contains detailed information on inpatient and outpatient claims, such as demographic data, dates of clinical visits, diagnostic codes, details of prescriptions and expenditure amounts. The International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) code was used in the NHIRD to define diagnostic diseases. However, personal information, including lifestyle, habits or family history, is not available from the NHIRD. The Institutional Review Board of our institution has reviewed and approved this study. No informed consent was necessary because this study analysed the secondary data.

Study population and definitions

All enrollees who were first diagnosed with retinoblastoma (ICD-9-CM code: 190.5) were obtained from the entire population of inpatient data of the NHIRD. We only included patients who had applied for a catastrophic illness certificate of retinoblastoma (Registry of Catastrophic Illness Database, a subpart of the NHIRD) or received clinical treatment during the observation period to confirm the diagnostic accuracy of retinoblastoma.

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At least two specialists validate the application of catastrophic illness certificates on the basis of careful examinations of medical records and laboratory and imaging studies. All the enrolled cases were born between 1998 and 2009, and were followed up until 2011 to ensure every case has been followed up for at least 2 years.

Statistical analysis
We calculated the incidences of retinoblastoma (per 1 million -person-years) based on their birth year and further reported stratified analyses by sex and subperiods of calendar years between 1998 and 2009. The numerator of incidence was the number of incident cases within the respective birth year period. The denominator was the population of all infants born alive between 1998 and 2009 according to the Statistical Yearbook of the Interior from the Taiwan Department of Statistics. Male and female incidence was calculated from per male and female born children, respectively. Temporal trends of incidences were investigated using Poisson regression model. Crude and adjusted ORs with 95% CI were estimated for variables associated with overall mortality by using univariate and multivariate Cox regression models. Four variables including diagnostic age, sex, period of birth year and enucleation were analysed in the multivariate model. Data analysis was performed by using SPSS software, V21 of the SPSS System for Windows (IBM Corporation, Somers, New York, USA). A two-tailed p<0.05 was considered significant.

RESULTS
Diagnostic age distribution
A total of 154 patients (92 males, 62 females) with retinoblastoma in Taiwan were identified from a population of children who were born alive between 1998 and 2009 based on the aforementioned criteria. The majority of cases appeared by 5 years of age, and no case was diagnosed later than 10 years of age (figure 1). The accumulated percentages of case numbers attained were 68.2%, 86.4% and 96.1% by 2, 3 and 5 years of life, respectively.

Trend of incidences during 1998–2009
The overall incidence of retinoblastoma was 57.56 per million live births (table 1), which corresponded to 1 per 17 373 live births. The incidence for males and females was 65.81 and 48.53 per million live births, respectively. Although the incidence for males was increased slightly across the study period, the female incidence seemed stable and Poisson regression analyses showed no significant change in the incidence rates of time trends for either males or females (figure 2).

Dynamic diagnostic age-specific sex ratio across ages
The overall ratio of male-to-female incidence was 1.36 (table 1). The age-specific sex ratio increased from 1.4 at age younger than 1 year to 3.0 above age 4 years (figure 1).

Factors associated with fatality rate
The multivariate analysis that disclosed cases receiving enucleation showed significantly lower risk of death with an OR of 0.27 (95% CI 0.10 to 0.61), but the diagnostic age, sex and calendar year of the birth cohorts were not associated with fatality rate (table 2). Enucleation was performed in 109 (70.8%) children with retinoblastoma, and it was more prevalent in males than in females (77.2% vs 61.3%, p=0.0335).

DISCUSSION
This was a nationwide population-based study which may avoid selection bias and provide a reliable estimate of the incidence of a rare disease like retinoblastoma. This study demonstrated that 70% of the total cases were diagnosed before 2 years of age and as few as 4% of cases were identified after 5 years of age. There was a male predominance with a rising male-to-female sex ratio as age increases. The intervention of enucleation was associated with a significantly lower fatality, compared with that among those retinoblastoma victims without eye removal surgery.

The present work demonstrated that the incidence rate of retinoblastoma in Taiwan during 1998–2011 was 1 per 17 373 live births, which is similar to that in other countries, such as 1 per 16 642 live births in Northern Europe, and 1 per 16 938 live births at least two specialists validate the application of catastrophic illness certificates on the basis of careful examinations of medical records and laboratory and imaging studies.
that the incidence of retinoblastoma among live-born children is
inoblastoma in the Asia-Paciﬁc region, based on the assumption
that the incidence of retinoblastoma among live-born children is
uniform in all countries. The predicted number may be used as
a surrogate to evaluate the completeness of registration for
retinoblastoma. Interestingly, the predicted number by its for-
mulation is 160, close to the observed number of 154 in our
study.

The retinoblastoma incidence rate among boys was higher
than that among girls (table 1), which is consistent with the
study of Wong et al but different from some previous studies
of no sex difference. One explanation for this sex difference
is related to cultural behaviour. For example, sons are more
favoured than daughters in Taiwan, which might cause more
male children to be brought to medical care than female
children, corresponding to our observation that females
signiﬁcantly underwent less enucleation than males. It could
correspondingly result in a higher mortality in females than
males.31 Some developed countries have justiﬁed the use of
chemoreduction and local therapy because these interven-
tions allow the patient to avoid radiation-related secondary
malignancies that develop in as many as 11% of irradiated
patients after 30 years.32 However, enucleation in low-resource
countries, where most children with retinoblastoma live, is often
the only available curative treatment.33 34 Even in resource-rich
countries, the evidence-based curative therapy for IIRC Group
E eyes is enucleation.21

There were some limitations of this present study. First, this
was a retrospective study to analyse reimbursement data which
did not include family history and personal information like life-
style, socioeconomic status, living area, signs or symptoms at
presentation, pathologic report and genetic information.
Therefore, we were unable to recognise the familial cases and the
investigation of risk factors associated with mortality was inevit-
ably affected. Second, the cancer stage and laterality were not
available in the current ICD-9-CM system that prohibited us to
analyse the outcomes of retinoblastoma that involved unilateral
or bilateral eyes. We hope the ICD-10-CM can provide more
detailed clinical information in the future. Finally, the sample size
in this study might be too small to show a statistical signiﬁcance;
however, that does not mean absence of clinical importance.

Table 2 Multivariable logistic regression analysis of fatality for cases with retinoblastoma

<table>
<thead>
<tr>
<th>Diagnostic age</th>
<th>Survival (N=128)</th>
<th>Death (N=26)</th>
<th>Mortality (%)</th>
<th>Univariate analysis</th>
<th>Multivariate analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;2 years</td>
<td>90</td>
<td>15</td>
<td>14.3</td>
<td>Ref. –</td>
<td>Ref. –</td>
</tr>
<tr>
<td>≥2 years</td>
<td>38</td>
<td>11</td>
<td>22.4</td>
<td>1.74 0.73–4.13</td>
<td>1.91 0.76 to 4.76</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>50</td>
<td>12</td>
<td>19.4</td>
<td>Ref. –</td>
<td>Ref. –</td>
</tr>
<tr>
<td>Male</td>
<td>78</td>
<td>14</td>
<td>15.2</td>
<td>0.75 0.32–1.75</td>
<td>0.90 0.37 to 2.23</td>
</tr>
<tr>
<td>Birth year</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1998–2004</td>
<td>63</td>
<td>17</td>
<td>21.3</td>
<td>Ref. –</td>
<td>Ref. –</td>
</tr>
<tr>
<td>2005–2011</td>
<td>65</td>
<td>9</td>
<td>12.2</td>
<td>0.51 0.21–1.24</td>
<td>0.47 0.19 to 1.18</td>
</tr>
<tr>
<td>Enucleation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>31</td>
<td>14</td>
<td>31.1</td>
<td>Ref. –</td>
<td>Ref. –</td>
</tr>
<tr>
<td>Yes</td>
<td>97</td>
<td>12</td>
<td>11.0</td>
<td>0.27 0.12–0.65</td>
<td>0.25 0.10 to 0.61</td>
</tr>
</tbody>
</table>

Conclusions
In conclusion, this nationwide population-based study has
updated the overall retinoblastoma incidence in the past decade

incidences of retinoblastoma and other childhood diseases may
be genetically related. However, the underlying mechanism
requires further investigation.

Enucleation is the curative treatment for this devastating eye
cancer, particularly for cases with clinical features suggesting a
risk of extracocular spread.30 However, the choice of performing
enucleation or not may be complex because it involves several
factors including clinical situations and families’ preference. For
example, some parents refuse enucleation because of their belief
in alternative treatments, culture and social stigma.30 The multi-
variate regression model in our study showed that the surgical
intervention of enucleation was signiﬁcantly associated with the
decline in mortality (OR=0.27, 95% CI 0.10 to 0.61). Early
identiﬁcation of this childhood eye tumour is essential in order
to reduce morbidity and mortality related to this ocular malign-
ancy.1 A previous study found that if enucleation was per-
fomed longer than 3 months after diagnosis, it would result in
worse outcome.31 Some developed countries have justiﬁed the
use of chemoreduction and local therapy because these interven-
tions allow the patient to avoid radiation-related secondary
malignancies that develop in as many as 11% of irradiated
patients after 30 years.32 However, enucleation in low-resource
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detailed clinical information in the future. Finally, the sample size
in this study might be too small to show a statistical signiﬁcance;
however, that does not mean absence of clinical importance.

in Taiwan to 1 in 17 373 live births. The incidence exhibited no marked trend over time after the implementation of NHI in 1995. There were more male cases than female cases and the male-to-female rate ratio rose with age. The survival outcome was significantly associated with the intervention of enucleation.

Contributors All authors have contributed equally to the research, from the title to drafting of work, methodology and approval of manuscript and accept full responsibility and accountability for the same.

Competing interests None declared.

Ethics approval Institutional Review Board of Dittmanson Medical Foundation Chia-Yi Christian Hospital has reviewed and approved this study.

Provenance and peer review Not commissioned; externally peer reviewed.

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