10.1071/AH21395
Australian Health Review

Supplementary Material

Hospitalisation costs of primary liver cancer in Australia: evidence from a data-linkage study

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Supplementary Material 1

Methods_extended

Study design, setting, data linkage process and data sources

This study linked four population-based datasets of patients diagnosed with PLC in Victoria, Australia. Victoria is the second-most populous state in Australia with a population of 6.6 million in 2019[1]. The data linkage was conducted by the Centre for Victorian Data Linkage (CVDL) following the Separation Principle to ensure that personal identifying information is kept separate from service or clinical data at all stages. The cohort was defined as all PLC notifications to the Victorian Cancer Registry (VCR) between 1/1/2008 and 31/12/2015. The VCR is a population-based cancer notification registry that holds records of all cancer diagnoses in Victoria since 1982[2]. All Victorian health services are required to notify the VCR when a cancer diagnosis is made. PLC cases were identified using the International Statistical Classification of Diseases and Related Health Problems, Tenth Revision, Australian Modification (ICD-10-AM) code of C22*. Supplementary table 1 provides the list of ICD-10-AM codes that were included.

Supplementary table 1. List of ICD-10-AM code for PLC

ICD-10-AM code	Description
C220	Liver cell carcinoma
C221	Intrahepatic bile duct carcinoma
C222	Hepatoblastoma
C223	Angiosarcoma of liver
C224	Other sarcomas of liver
C227	Other specified carcinomas of liver
C229	Malignant neoplasm of liver unspecified

The CVDL generated a unique Project Person Identifier (PPID) for each individual from the cohort to link all the records of each individual across the other datasets via the Integrated Data Resource. The other datasets included the Victorian Admitted Episodes Dataset (VAED), the Victorian Emergency Minimum Dataset (VEMD) and the Victorian Death Index (VDI). The CVDL extracted the clinical data for each PPID and provided this to the researchers without the individual's source identifier. The researchers merged each dataset received from the CVDL using the PPIDs.

Public hospital admitted episodes of care

An episode of care is defined as the phase of admitted treatment between a formal or statistical admission and a formal or statistical separation, characterised by only one care type such as: acute, subacute (Rehabilitation, Palliative care, Geriatric evaluation and management and Psychogeriatric care), non-acute (Maintenance care) or Mental health care[3]. Supplementary table 2 provides the number of episode of care based on care type.

Supplementary table 2. Number of episode of care based on care types

Care types	12 months after notification	12 - 24 months after notification
Acute care	17,824 (94.0%)	5,274 (95.0%)
Palliative care	827 (4.4%)	190 (3.4%)
Other sub- and non-acute care	308 (1.6%)	85 (1.5%)

Each admitted episode of care in the VAED was assigned with a principal diagnosis and up to 39 other diagnoses, reflecting the clinically relevant conditions for each admission and coded using the ICD-10-AM classification. In addition, up to 40 interventions used during the admission were reported, coded on the Australian Classification of Health Interventions (ACHI) codes[4]. The health information managers or clinical coders (not researchers) were responsible for coding the disease classification and interventions. Based on these codes, the Australian Refined Diagnosis Related Group (AR-DRG) for that episode of care was then assigned.

Economic Analysis

NHCDC (DRG) costs

The cost for each admitted episode of care was calculated using the National Hospital Cost Data Collection (NHCDC) cost. The NHCDC is an annual collection of public hospital data published by The Independent Hospital Pricing Authority that reports average cost for each AR-DRG code[5]. All admitted episodes of care were therefore costed using the NHCDC (or DRG) cost for AR-DRG Version 10.0 from the Round 22 (2017-18)[5]. Hence, costs are expressed in 2017 Australian dollars.

The AR-DRG code group Z60 - "Rehabilitation" was removed in the latest version (10.0) of AR-DRG due to the updated Australian Coding Standards. As a result, rehabilitation episodes are grouped to DRGs according to a principal diagnosis that reflects the condition for which

the rehabilitation is provided[6]. In order to reflect that change, we recoded old Z60 rehabilitation codes to the principal diagnosis of the patient before commencing rehabilitation, i.e., the principal diagnosis of the previous episode of care.

ED costs

Costs related to the ED presentations were determined by the Urgency Disposition Group (UDG) costing method. Costs for each ED presentation were estimated by multiplying the base payment, reported as the National Efficient Price[7], by the UDG price weight. The UDG is determined by the type of ED visit, triage category and separation mode[7]. In Australia, the triage category is classified into five levels based on the clinical urgency and maximum waiting time for treatment of patients[8]:

1 - Resuscitation: Immediate (within seconds)

2 - Emergency: Within 10 minutes

3 - Urgent: Within 30 minutes

4 - Semi-urgent: Within 60 minutes

5 - Non-urgent: Within 120 minutes

The total and mean costs are reported, and all costs are reported in 2017 AUD.

Survival estimation

Survival was calculated from the date the patient was diagnosed with PLC to the date of death as reported in the VDI. We classified patient survival in the following categories: < 1 year; 1-2 years; 2+ years. As the data is right-censored, which means the death of some individuals occurred beyond the end of this study, we used the patients' date of PLC diagnosis to classify them into different categories for those who were alive at 31/12/2015:

- > 2 years of survival: those diagnosed before 01/2014
- 1-2 years of survival: those diagnosed after 01/2014 and before 01/2015
- < 1 year of survival: those diagnosed after 01/2015.

These categories were used in the national cost extrapolation and in the model for exploring factors associated with PLC costs (section 2.5 for more details)

Ethics approval

Ethical approvals were obtained from the Victorian Department of Health and Human Services' Human Research Ethics Committee (approval number AM/52055/DHHS-2020-210154) and the Human Research Ethics Committee, University of Tasmania (approval number H0018123).

Reference

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3. Australian Institute for Health and Welfare. Admitted patient care 2017–18: Australian hospital statistics. Canberra; 2019.
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5. Independent Hospital Pricing Authority (IHPA). National Hospital Cost Data Collection Report, Public Sector, Round 22 (Financial year 2017-18) 2020. Available from: https://www.ihpa.gov.au/publications/national-hospital-cost-data-collection-report-public-sector-round-22-financial-year.
6. Independent Hospital Pricing Authority (IHPA). Australian Refined Diagnosis Related Groups (AR-DRG) Version 10.0 2019. Available from: https://www.ihpa.gov.au/admitted-acute-care/australian-refined-diagnosis-related-groups-ar-drg-version-100.
7. Independent Hospital Pricing Authority. National Efficient Price Determination 2017-18 2017. Available from: https://www.ihpa.gov.au/publications/national-efficient-price-determination-2017-18.
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Supplementary Material 2

Supplementary Table 3. Median; Mean (standard deviation) number of hospital admission by characteristics of patients, 2008 – 2015

	12 months after notification	12 - 24 months after notification
Number of admission	3; 5.7 (8.4)	3; 5.4 (10.8)
Sex		
Male	3; 5.5 (8.9)	3; 5.3 (11.7)
Female	4; 6.3 (7.2)	3; 5.6 (7.1)
Age group		
<40	7; 10.9 (10.1)	5; 6.9 (7.4)
40-59	3; 6.3 (7.6)	3; 6.0 (11.6)
60-79	3; 6.0 (9.8)	3; 5.3 (11.3)
>79	3; 3.7 (3.9)	2; 3.6 (5.0)
Seifa		
1-Most disadvantaged	3; 5.1 (7.7)	3; 5.5 (11.5)
2	3; 5.5 (6.3)	2; 4.5 (5.9)
3	3; 5.8 (7.2)	2; 4.5 (6.4)
4	3; 5.9 (9.4)	3; 5.7 (8.6)
5- Least disadvantaged	4; 7.0 (11.9)	3; 7.0 (17.8)
Types of liver cancer		
HCC	3; 4.7 (7.9)	2; 4.6 (11.9)
Cholangiocarcinoma	4; 8.4 (9.3)	4; 7.4 (8.6)
Other types	3; 4.9 (7.9)	3; 5.6 (8.9)
Survival year		
<1 year	3; 4.8 (5.3)	N.A
1-2 years	5; 8.2 (12.0)	3; 4.8 (6.3)
>2 years	4; 6.3 (10.7)	3; 5.9 (13.4)
Birth region		
ANZ	3; 5.9 (7.3)	3; 5.7 (10.0)
Europe	4; 5.8 (9.0)	3; 4.9 (7.1)
Asia	3; 4.7 (11.1)	2; 5.6 (18.5)
Africa	4; 5.8 (7.0)	2; 5.2 (7.6)
America	3; 7.4 (9.9)	2; 3.6 (3.5)
Other	4; 6.7 (9.3)	3; 7.4 (11.1)

ANZ, Australia and New Zealand; HCC, Hepatocellular Carcinoma

Supplementary Table 4. Inpatient + ED costs by different age groups, 2008 - 2015

	12 months after notification			12 - 24 months after notification		
	Total costs from 2008 to 2015	Annualized cost	Annual cost per patient (SD)	Total costs from 2009 to 2015	Annualized cost	Annual cost per patient (SD)
Patients < 40 years old						
Inpatient cost		**n = 81**			**n = 29**	
	8,781,341	1,097,668	108,412 (96,040)	1,609,050	229,864	55,484 (76,382)
ED cost		**n = 65**			**n = 20**	
	198,651	24,831	3,056 (2,481)	43,652	6,236	2183 (1,821)
Total cost		**n = 81**			**n = 30**	
	8,979,991	1,122,499	110,864 (97,129)	1,652,702	236,100	55,090 (76,807)
Patients from 40 to 59 years old						
Inpatient cost		**n = 901**			**n = 330**	
	68,748,833	8,593,604	76,303 (70,749)	19,286,828	2,755,261	58,445 (64,928)
ED cost		**n = 619**			**n = 207**	
	1,397,477	174,685	2,258 (2,061)	408,693	58,385	1,974 (1,694)
Total cost		**n = 905**			**n = 343**	
	70,146,312	8,768,289	77,510 (71,379)	19,695,522	2,813,646	57,421 (65,167)
Patients from 60 to 79 years old						
Inpatient cost		**n = 1,689**			**n = 549**	
	105,737,329	13,217,166	62,604 (55,302)	24,147,116	3,449,588	43,984 (57,113)
ED cost		**n = 1,094**			**n = 320**	
	2,203,309	275,414	2,014 (1,769)	595,769	85,110	1,862 (1,537)
Total cost		**n = 1,698**			**n = 562**	
	107,940,632	13,492,579	63,569 (55,919)	24,742,884	3,534,698	44,026 (57,459)
Patients from 80 years old						
Inpatient cost		**n = 631**			**n = 120**	
	23,697,535	2,962,192	37,556 (34,516)	3,138,444	448,349	26,154 (26,616)
ED cost		**n = 398**			**n = 72**	
	664,419	83,052	1,669 (1,076)	140,023	20,003	1,945 (1,758)
Total cost		**n = 637**			**n = 121**	
	24,361,952	3,045,244	38,245 (34,974)	3,278,467	468,352	27,095 (27,182)

ED, Emergency Department; SD, Standard Deviation

Supplementary Material 3: CHEERS Checklist
Items to include when reporting economic evaluations of health interventions

The **ISPOR CHEERS Task Force Report**, *Consolidated Health Economic Evaluation Reporting Standards (CHEERS)—Explanation and Elaboration: A Report of the ISPOR Health Economic Evaluations Publication Guidelines Good Reporting Practices Task Force*, provides examples and further discussion of the 24-item CHEERS Checklist and the CHEERS Statement. It may be accessed via the *Value in Health* or via the ISPOR Health Economic Evaluation Publication Guidelines – CHEERS: Good Reporting Practices webpage: http://www.ispor.org/TaskForces/EconomicPubGuidelines.asp

Section/item	Item No	Recommendation	Reported on page No/ line No
Title and abstract			
Title	1	Identify the study as an economic evaluation or use more specific terms such as "cost-effectiveness analysis", and describe the interventions compared.	Page 1
Abstract	2	Provide a structured summary of objectives, perspective, setting, methods (including study design and inputs), results (including base case and uncertainty analyses), and conclusions.	Page 1
Introduction			
Background and objectives	3	Provide an explicit statement of the broader context for the study. Present the study question and its relevance for health policy or practice decisions.	Page 2
Methods			
Target population and subgroups	4	Describe characteristics of the base case population and subgroups analysed, including why they were chosen.	Section 2.1
Setting and location	5	State relevant aspects of the system(s) in which the decision(s) need(s) to be made.	Section 2.1
Study perspective	6	Describe the perspective of the study and relate this to the costs being evaluated.	Section 2.2
Comparators	7	Describe the interventions or strategies being compared and state why they were chosen.	N.A
Time horizon	8	State the time horizon(s) over which costs and consequences are being evaluated and say why appropriate.	N.A
Discount rate	9	Report the choice of discount rate(s) used for costs and outcomes and say why appropriate.	N.A
Choice of health outcomes	10	Describe what outcomes were used as the measure(s) of benefit in the evaluation and their relevance for the type of analysis performed.	N.A
Measurement of effectiveness	11a	*Single study-based estimates:* Describe fully the design features of the single effectiveness study and why the single study was a sufficient source of clinical effectiveness data.	N.A

	11b	*Synthesis-based estimates:* Describe fully the methods used for identification of included studies and synthesis of clinical effectiveness data.	N.A
Measurement and valuation of preference based outcomes	12	If applicable, describe the population and methods used to elicit preferences for outcomes.	N.A
Estimating resources and costs	13a	*Single study-based economic evaluation:* Describe approaches used to estimate resource use associated with the alternative interventions. Describe primary or secondary research methods for valuing each resource item in terms of its unit cost. Describe any adjustments made to approximate to opportunity cost.	Section 2.2
	13b	*Model-based economic evaluation:* Describe approaches and data sources used to estimate resource use associated with model health states. Describe primary or secondary research methods for valuing each resource item in terms of its unit cost. Describe any adjustments made to approximate to opportunity costs.	N.A
Currency, price date, and conversion	14	Report the dates of the estimated resource quantities and unit costs. Describe methods for adjusting estimated unit costs to the year of reported costs if necessary. Describe methods for converting costs into a common currency base and the exchange rate.	Section 2.2
Choice of model	15	Describe and give reasons for the specific type of decision-analytical model used. Providing a figure to show model structure is strongly recommended.	N.A
Assumptions	16	Describe all structural or other assumptions underpinning the decision-analytical model.	N.A
Analytical methods	17	Describe all analytical methods supporting the evaluation. This could include methods for dealing with skewed, missing, or censored data; extrapolation methods; methods for pooling data; approaches to validate or make adjustments (such as half cycle corrections) to a model; and methods for handling population heterogeneity and uncertainty.	Section 2.3
Results			
Study parameters	18	Report the values, ranges, references, and, if used, probability distributions for all parameters. Report reasons or sources for distributions used to represent uncertainty where appropriate. Providing a table to show the input values is strongly recommended.	Section3.2-3.4
Incremental costs and outcomes	19	For each intervention, report mean values for the main categories of estimated costs and outcomes of interest, as well as mean differences between the comparator groups. If applicable, report incremental cost-effectiveness ratios.	N.A
Characterising uncertainty	20a	*Single study-based economic evaluation:* Describe the effects of sampling uncertainty for the estimated incremental cost and incremental effectiveness parameters, together with the impact	N.A

		of methodological assumptions (such as discount rate, study perspective).	
	20b	*Model-based economic evaluation:* Describe the effects on the results of uncertainty for all input parameters, and uncertainty related to the structure of the model and assumptions.	N.A
Characterising heterogeneity	21	If applicable, report differences in costs, outcomes, or cost-effectiveness that can be explained by variations between subgroups of patients with different baseline characteristics or other observed variability in effects that are not reducible by more information.	N.A
Discussion			
Study findings, limitations, generalisability, and current knowledge	22	Summarise key study findings and describe how they support the conclusions reached. Discuss limitations and the generalisability of the findings and how the findings fit with current knowledge.	Section 4
Other			
Source of funding	23	Describe how the study was funded and the role of the funder in the identification, design, conduct, and reporting of the analysis. Describe other non-monetary sources of support.	Title Page
Conflicts of interest	24	Describe any potential for conflict of interest of study contributors in accordance with journal policy. In the absence of a journal policy, we recommend authors comply with International Committee of Medical Journal Editors recommendations.	Title Page

For consistency, the CHEERS Statement checklist format is based on the format of the CONSORT statement checklist

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The citation for the CHEERS Task Force Report is:
Husereau D, Drummond M, Petrou S, et al. Consolidated health economic evaluation reporting standards (CHEERS)—Explanation and elaboration: A report of the ISPOR health economic evaluations publication guidelines good reporting practices task force. Value Health 2013;16:231-50.