Sociodemographic and clinical factors for non-hospital deaths among cancer patients: A nationwide population-based cohort study

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Background
Factors associated with place of death inform policies with respect to allocating end-of-life care resources and tailoring supportive measures.

Objective
To determine factors associated with non-hospital deaths among cancer patients.

Design
Retrospective cohort study of cancer decedents, examining factors associated with non-hospital deaths using multinomial logistic regression with hospital deaths as the reference category.

Setting/subjects
Cancer patients (n = 15254) in Singapore who died during the study period from January 1, 2012 till December 31, 2015 at home, acute hospital, long-term care (LTC) or hospice were included.

Results
Increasing age (categories ≥65 years: RRR 1.25–2.61), female (RRR 1.40; 95% CI 1.28–1.52), Malays (RRR 1.67; 95% CI 1.47–1.89), Brain malignancy (RRR 1.92; 95% CI 1.15–3.23), metastatic disease (RRR 1.33–2.01) and home palliative care (RRR 2.11; 95% CI 1.95–2.29) were associated with higher risk of home deaths. Patients with low socioeconomic status were more likely to have hospice or LTC deaths: those living in smaller housing
types had higher risk of dying in hospice (1–4 rooms apartment: RRR 1.13–3.17) or LTC (1–
5 rooms apartment: RRR 1.36–4.11); and those with Medifund usage had higher risk of
dying in LTC (RRR 1.74; 95% CI 1.36–2.21). Patients with haematological malignancies
had increased risk of dying in hospital (categories of haematological subtypes: RRR 0.06–
0.87).

**Conclusions**

We found key sociodemographic and clinical factors associated with non-hospital deaths in
cancer patients. More can be done to enable patients to die in the community and with dig-
nity rather than in a hospital.

**Introduction**

Cancer is a leading cause of death globally, accounting for an estimated 9.6 million deaths in
2018. [1] A large proportion of cancer deaths occur in hospitals for many developed countries.
[2,3] Similar to global trends, cancer incidence is on the rise in Singapore; with cancer
accounting for 30% of total population mortality. [4,5] Additionally, more than 50% of cancer
decedents die in Singapore hospitals, [6,7] despite a majority patient preference for home
deaths. [8–12]

Respecting preferences in terms of place of care and death is important. [13] Good cancer
care includes a consideration of a patient’s needs, goals and preferences throughout their
course of illness. [14] Respecting such preferences may provide better holistic well-being,
increased peace and less intense grief for families. [15,16] Studies done in Singapore profiling
end-of-life care preferences suggest most cancer patients prefer to die at home. [8–10,17] Such
preferences remain relatively stable over trajectory of illness. [18]

Place of death is also a recognised quality indicator for end-of-life care. [19] Dying from
cancer in hospitals is considered overly aggressive end-of-life care. [20–23] Costs for aggressive
end-of-life care are substantially higher, driven by heavy dependence on hospitalizations. [24–
28] Local data in Singapore suggests that hospitalizations are the largest driver of healthcare
spending for oncology care. [29]

To develop services that effectively reduce hospital deaths, reduce costs and support dying
in patients’ preferred place, understanding factors associated with non-hospital deaths in can-
cer patients is needed. These factors inform public health policies with respect to allocation of
end-of-life care resources and tailoring supportive measures.

A systematic review of Western countries found 17 factors associated with place of death.
Six factors were strongly associated with home deaths: low functional status, patient prefer-
ences for home death, use of home care, intensity of home care, living with relatives and
extended family support. Conversely, non-solid tumours, ethnic minorities, previous admis-
sions to hospitals and areas with greater hospital provision were associated with hospital
deaths. [30] Literature specific to Asia suggest that marital status, poor functional status, hav-
ing multidisciplinary home palliative care, lower caregiver burden and patient and family prefer-
ences increased the likelihood of dying at home. [31–35] Within Singapore, factors found to be
associated with home death include age, female gender, Malay ethnicity, receipt of home
palliative care, having a caregiver, non-cancer diagnosis, fewer prior hospitalizations and a
preference for home death. [6,7,36]
While a recent systematic review concluded that low socioeconomic status increased the odds of hospital deaths, this conclusion was weaker for Asian countries due to a lack of published studies within this region. [37] To the best of our knowledge, local literature defining cancer specific risk factors for hospital deaths is also currently lacking; and remains critical in future identification of patients with unmet needs.

To meet the gap in literature, the primary objective of this study was to explore the influence of socioeconomic factors and clinical factors on places of death. We used the US National Cancer Institute’s Surveillance, Epidemiology, and End Results (SEER) categorisation of cancer types to increase granularity in examining cancer types. [38]

Methods
Setting, study design and participants
Cancer care in Singapore is predominantly provided within tertiary public institutions through a mixture of government subsidies, compulsory savings, compulsory national health-care insurance and a state-provided “safety net”. [39] In recent years, to improve care across the cancer continuum, there have been increasing efforts to transition care to the community by empowering and increasing resources to community hospice providers. [40]

A retrospective national cohort study was conducted using state-wide administrative data of inpatient admissions, financial claims from the Ministry of Health (MOH) and death records from the Singapore Registry of Births and Deaths. [41]

Singapore residents who were discharged alive from hospital with a primary discharge diagnosis of cancer based on International Classification of Diseases codes (ICD-10-AM:C00-C96) between January 1, 2012 and December 31, 2015, and a recorded death in the national death registry by December 31, 2015 were included in this study. Patients with unnatural deaths at sites such as roads (e.g. traffic accidents), ground floor of residential apartment blocks and reservoirs (possibly suicides) were excluded from the study (n = 52).

The STROBE guidelines were used for the reporting of this observational study. [42]

Dependant variable
Place of death was as recorded in the patient’s death certificate and categorised as hospital, home, hospice and long-term care facilities (LTC)

Independent variables
Socioeconomic variables were defined by three different aspects. First, we examined housing subsidy via mapping residential postal codes to housing type. Housing type (categorised by level of housing subsidy, ranging from private / non-subsidized housing, to intermediate subsidy with restrictions on resale and rental, to maximal subsidy, non-market housing) correlates with income status due to the public subsidized housing system in Singapore where income ceilings determine housing type eligibility. [43–45] Second, we calculated average monthly household income per capita percentiles based on the eligibility cut-off tiers for subsidized primary care under the Community Health Assist Scheme (CHAS). [46,47] Third, financial data on inpatient admissions paid from the government Medical Endowment Scheme (Medifund) was used. Medifund is a discretionary government-funded safety net to help the neediest Singaporeans with high post-subsidy inpatient bills, and takes into consideration the applicant’s financial, health and social circumstances. [48]

Clinical information was extracted from discharge diagnoses (age, gender, ethnicity, cancer sites, comorbidities) and admission records (length of stay, discharge disposition). We
categorised ethnicity as Chinese, Malay, Indian and Others in accordance with the national approach towards racial categories. [49] Comorbid burden was computed using the Charlson Comorbidity Index (CCI). [50] Primary cancer sites were grouped by two-digit ICD-10-CM codes according to the SEER codes for cancers deemed to be single site primaries. [38] Metastases were grouped by three-digit SEER codes into brain, bone, lymph node, lung, liver, other gastrointestinal and other metastases. Status of home palliative care involvement was obtained from MOH Agency for Integrated Care records. [51]

The only variables with missing data were housing type (416, 2.72%) and ethnicity (144, 0.94%). Patients with missing variables were included in the analysis as “missing category”.

Statistical analysis
Differences in mean of continuous variable by places of death were compared using Analysis of Variance. Corresponding differences in categorical variable were compared using chi-square test or Fisher’s exact test, as appropriate. Multivariable multinomial logistic regression analyses were used to estimate relative risk ratios (RRR) to examine the association between places of death and various covariates. Hospital death was used as the reference category and all independent variables listed above were included as covariates in the model. Sixty-six predictors were tested which was below the maximum number of predictors that could be fitted given total sample size and number of responses in each place of death category. [52] Model diagnostics were performed in which Wald tests were used to examine whether places of death categories could be combined, and spearman correlations were used to identify potential multicollinearity between independent variables. Sensitivity analyses were performed to examine the impact of outliers.

STATA version 13.0 (StataCorp) was used to perform statistical analysis. A two-sided \( p < 0.05 \) was considered statistically significant.

Research ethics and patient consent
This study was approved by SingHealth Central Institutional Review Board (CIRB Ref No: 2017/2908). Research and analysis were done on deidentified data. Waiver of requirement for informed consent was granted.

Results
A total of 15254 decedents met the study eligibility criteria and were analysed. Within this cohort, 6.69% passing away in LTC, 14.38% in a hospice, 33.14% at home, and 45.79% in hospital. Mean (SD) age was 68 (13.6) years, majority were Chinese (81.05%) and 56.29% were male. Lung (21.40%), liver (9.39%), colon (9.37%), breast (7.28%) and stomach (6.14%) made up the top five solid organ malignancies, while 6.85% had haematological malignancies. Thirty-two percent received home palliative care before their deaths.

Table 1 and S1 Table summarises the distribution of each independent variable by places of death. Variables with small cell counts were reported as <5 to respect confidentiality of patients. There were distinct differences in sociodemographic characteristics of decedents by places of death. Decedents who passed away at hospital and hospice were younger than those who died at home and LTC. Malays and decedents who had home palliative care were more likely to pass away at home, while decedents with lower socioeconomic status (Medifund, <20th income percentile, living in 1–2 room apartments) were less likely to do so.

The results from our multinomial logistic regression model are presented in Table 2. Sensitivity analyses excluding outliers made no appreciable differences to the estimates of the model.
Table 1. Sociodemographic and clinical characteristics of decedents by place of death.

| Variable                  | Hospital | Home | Hospice | LTC  | P value |
|---------------------------|----------|------|---------|------|---------|
|**Total**                  | 6985 (100.0) | 5055 (100.0) | 2194 (100.0) | 1020 (100.0) |         |
| **Gender**                |          |      |         |      |         |
| Male                      | 4150 (59.41) | 2543 (50.31) | 1347 (61.39) | 547 (53.63) | $<0.001$ |
| Female                    | 2835 (40.59) | 2512 (49.69) | 847 (38.61) | 473 (46.37) |         |
| **Age, years**            |          |      |         |      |         |
| &lt;17                    | 35 (0.50) | 16 (0.32) | 1 (0.05) | 0 (0) | $<0.001$ |
| 17–34                     | 118 (1.69) | 44 (0.87) | 18 (0.82) | 2 (0.20) |         |
| 35–44                     | 238 (3.41) | 128 (2.53) | 64 (2.92) | 11 (1.08) |         |
| 45–54                     | 848 (12.14) | 430 (8.51) | 242 (11.03) | 86 (8.43) |         |
| 55–64                     | 1756 (25.14) | 1034 (20.45) | 553 (25.21) | 221 (21.67) |         |
| 65–74                     | 1906 (27.29) | 1286 (25.44) | 614 (27.99) | 274 (26.86) |         |
| 75–84                     | 1567 (22.43) | 1428 (28.25) | 518 (23.61) | 280 (27.45) |         |
| &gt;85                    | 517 (7.40) | 689 (13.63) | 184 (8.39) | 146 (14.31) |         |
| Mean (SD)                 | 66.3 (13.7) | 70.2 (13.6) | 67.7 (12.7) | 71.0 (12.2) | $<0.001$ |
| **Race**                  |          |      |         |      |         |
| Chinese                   | 5565 (79.67) | 3930 (77.74) | 1973 (89.93) | 896 (87.84) | $<0.001$ |
| Indian                    | 322 (4.61) | 174 (3.44) | 63 (2.87) | 27 (2.65) |         |
| Malay                     | 678 (9.71) | 647 (12.80) | 88 (4.01) | 54 (5.29) |         |
| Others                    | 345 (4.94) | 260 (5.14) | 55 (2.51) | 34 (3.33) |         |
| Missing                   | 75 (1.07) | 44 (0.87) | 15 (0.68) | 9 (0.88) |         |
| **CCI score**             |          |      |         |      |         |
| 0                         | 3350 (47.96) | 2318 (45.86) | 1131 (51.55) | 467 (45.78) | $<0.001$ |
| 1                         | 1392 (19.93) | 1129 (22.33) | 436 (19.87) | 196 (19.22) |         |
| 2                         | 693 (9.92) | 503 (9.95) | 220 (10.03) | 109 (10.69) |         |
| 3                         | 489 (7.00) | 373 (7.38) | 155 (7.06) | 77 (7.55) |         |
| &gt;4                      | 1061 (15.19) | 732 (14.48) | 252 (11.49) | 171 (16.76) |         |
| **Medifund Use**          |          |      |         |      |         |
| Yes                       | 453 (6.49) | 214 (4.23) | 164 (7.47) | 116 (11.37) | $<0.001$ |
| No                        | 6532 (93.51) | 4841 (95.77) | 2030 (92.53) | 904 (88.63) |         |
| **CHAS Income Percentile**|          |      |         |      |         |
| &lt;20th percentile       | 1983 (28.39) | 1409 (27.87) | 745 (33.96) | 367 (35.98) | $<0.001$ |
| 20th-50th percentile      | 355 (5.08) | 266 (5.26) | 106 (4.83) | 56 (5.49) |         |
| &gt;50th percentile       | 4647 (66.53) | 3380 (66.86) | 1343 (61.21) | 597 (58.53) |         |
| **Housing Subsidy**       |          |      |         |      |         |
| 1–2 Room Apartment        | 331 (4.74) | 187 (3.70) | 233 (10.62) | 130 (12.75) | $<0.001$ |
| 3 Room Apartment          | 1982 (28.38) | 1351 (26.73) | 743 (33.87) | 287 (28.14) |         |
| 4 Room Apartment          | 2194 (31.41) | 1655 (32.74) | 608 (27.71) | 280 (27.45) |         |
| 5 Room/Executive Apartment| 1449 (20.74) | 1171 (23.17) | 351 (16.00) | 169 (16.57) |         |
| Private Housingd           | 836 (11.97) | 612 (12.11) | 193 (8.80) | 78 (7.65) |         |
| Missing                   | 191 (2.76) | 79 (1.56) | 66 (3.01) | 76 (7.45) |         |
| **Mean Length of Stay of Index Admission (SD), days** | 10.1 (13.6) | 9.9 (12.1) | 13.4 (16.2) | 14.0 (21.5) | $<0.001$ |
| **Final Deposition of Index Admission** |          |      |         |      |         |
| Discharged                | 5989 (85.74) | 4411 (87.26) | 1541 (70.24) | 606 (59.41) | $<0.001$ |
| Transferredb              | 606 (8.68) | 410 (8.11) | 152 (6.93) | 89 (8.73) |         |
| Othersc                   | 390 (5.58) | 234 (4.63) | 501 (22.84) | 325 (31.86) |         |
| **Home Palliative Care Involvement** |          |      |         |      |         |

(Continued)
Home death vs hospital death
Independent factors associated with higher risks of dying at home than in hospitals were increasing age, females, Malay and Other ethnicities, receipt of home palliative care, being non-Medifund aided and having less comorbidities. (Table 2)

Hospice death vs hospital death
Independent factors associated with higher risks of dying in hospice than hospitals were Chinese, having fewer comorbidities, living in smaller subsidized housing types and being discharged against advice or abscondment during index hospitalisation. (Table 2)

Long-Term Care (LTC) death vs hospital death
Independent factors associated with higher risks of dying in LTC than hospitals were older age, females, Chinese, Medifund recipients, living in smaller subsidized housing types and being transferred to another tertiary institute, discharged against advice or absconded during index hospitalisation. (Table 2)

Cancer-specific risk factors for hospital deaths and out-of-hospital deaths
Patients with solid organ tumours such as Breast, Prostate, Lung and other rarer sites had increased risk of dying in hospitals rather than home or hospice. Most haematological malignancies had higher risk for dying in hospital.

Primary brain malignancy and having metastatic cancer (e.g. brain metastases, bone metastases) were associated with increased risk for out-of-hospital deaths. (Table 2)

Discussion
In this study, a large proportion of cancer patients (45.64%) died in hospitals while only 33.03% died at home and 21.07% in LTC/hospice. Like previous local studies, we confirm older age, female, Malay ethnicity and home palliative care involvement to be associated with home deaths. [6,7] Additionally, we found that primary brain cancer, metastatic disease and non-Medifund patients were more likely to die at home.

From our analysis, low SES patients (smaller housing types, Medifund recipients) were more likely to pass away in LTC or hospices rather than hospitals. Being discharged against advice or abscondment from hospital, which we classify as high-risk behaviours with possible underlying social and financial needs, was also strongly associated with LTC and hospice deaths. This contrasts with a recent systematic review that included studies mostly from the

Table 1. (Continued)

| Variable | Hospital | Home | Hospice | LTC |
|----------|----------|------|---------|-----|
| Yes      | 1872 (26.80) | 2187 (43.26) | 579 (26.39) | 274 (26.86) | <0.001 |
| No       | 5113 (73.20) | 2868 (56.74) | 1615 (73.61) | 746 (73.14) |     |

Abbreviations: LTC, Long-Term Care Facilities; CCI, Charlson Comorbidity Index excluding cancer; Medifund, Medical Endowment Fund Scheme; CHAS, Community Health Assist Scheme.
a Included condominiums and landed properties  
b To another tertiary healthcare institution  
c Discharged against advice or abscondment  

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Table 2. Association of places of death with sociodemographic and clinical characteristics.

| Variable                                      | Relative Risk Ratio (95% CI) | Base category for places of death in multinomial logistic model = Hospital |
|------------------------------------------------|-----------------------------|--------------------------------------------------------------------------|
| Gender (ref: Male)                             |                             |                                                                           |
| Female                                         | 1.40 (1.28–1.52)            | 0.95 (0.84–1.07)                                                         | 1.27 (1.08–1.49) |
| P value                                        | 0.005                       |                                                                          |
| Age, years (ref: 55–64)                        |                             |                                                                           |
| < 17                                           | 0.65 (0.33–1.27)            | 0.207                                                                    | 0.09 (0.01–0.70) |
| 17–34                                          | 0.57 (0.39–0.84)            | 0.005                                                                    | 0.61 (0.35–1.06) |
| 35–44                                          | 0.82 (0.64–1.04)            | 0.102                                                                    | 1.02 (0.75–1.39) |
| 45–54                                          | 0.76 (0.66–0.88)            | <0.001                                                                   | 0.93 (0.78–1.12) |
| 65–74                                          | 1.25 (1.12–1.39)            | <0.001                                                                   | 1.01 (0.87–1.16) |
| 75–84                                          | 1.77 (1.58–1.98)            | <0.001                                                                   | 1.00 (0.89–1.17) |
| ≥85                                            | 2.61 (2.24–3.03)            | <0.001                                                                   | 1.06 (0.85–1.31) |
| Race (ref: Chinese)                            |                             |                                                                           |
| Indian                                         | 0.88 (0.72–1.07)            | 0.199                                                                    | 0.60 (0.45–0.80) |
| Malay                                          | 1.67 (1.47–1.89)            | <0.001                                                                   | 0.35 (0.28–0.45) |
| Others                                         | 1.24 (1.04–1.48)            | 0.016                                                                    | 0.50 (0.37–0.67) |
| CCI score (ref: 0)                             |                             |                                                                           |
| 1                                              | 1.09 (0.99–1.21)            | 0.091                                                                    | 0.90 (0.78–1.03) |
| 2                                              | 0.93 (0.81–1.06)            | 0.279                                                                    | 0.88 (0.73–1.05) |
| 3                                              | 0.96 (0.82–1.12)            | 0.563                                                                    | 0.89 (0.72–1.09) |
| ≥4                                             | 0.86 (0.76–0.97)            | 0.012                                                                    | 0.67 (0.56–0.79) |
| Medifund Use (ref: No)                         |                             |                                                                           |
| Yes                                            | 0.69 (0.58–0.83)            | <0.001                                                                   | 1.10 (0.90–1.35) |
| CHAS Income Percentile (ref: > 50th percentile) |                             |                                                                           |
| 20th - 50th percentile                         | 0.95 (0.80–1.13)            | 0.559                                                                    | 0.99 (0.78–1.25) |
| < 50th percentile                              | 0.92 (0.84–1.01)            | 0.065                                                                    | 1.06 (0.94–1.19) |
| Housing Type (ref: Private Housing)            |                             |                                                                           |
| 1–2 Room Apartment                              | 0.83 (0.66–1.03)            | 0.091                                                                    | 3.17 (2.48–4.05) |
| 3 Room Apartment                               | 0.95 (0.83–1.09)            | 0.488                                                                    | 1.65 (1.37–2.00) |
| 4 Room Apartment                               | 1.07 (0.94–1.22)            | 0.301                                                                    | 1.23 (1.02–1.49) |
| 5 Room/Executive Apartment                     | 1.11 (0.97–1.27)            | 0.147                                                                    | 1.13 (0.92–1.39) |
| Length of Stay of Index Admission (per day increase) | 1.00 (1.00–1.00)            | 0.939                                                                    | 1.01 (1.00–1.01) |
| Final Disposition of Index Admission(ref: Discharged) | 1.00 (0.86–1.15)            | 0.951                                                                    | 0.93 (0.77–1.13) |
| Transferred                                    | 1.00 (0.86–1.15)            | 0.951                                                                    | 1.50 (1.17–1.92) |
| Others                                         | 0.83 (0.70–0.99)            | 0.043                                                                    | 4.28 (3.66–5.01) |
| Home Palliative Care (ref: No)                 |                             |                                                                           |
| Yes                                            | 2.11 (1.95–2.29)            | <0.001                                                                   | 1.09 (0.97–1.22) |
| Primary Cancer Site                            |                             |                                                                           |
| Other Head and Neck                            | 0.49 (0.22–1.08)            | 0.076                                                                    | 0.49 (0.19–1.27) |
| Tongue                                         | 0.51 (0.26–1.00)            | 0.052                                                                    | 0.73 (0.34–1.56) |
| Oropharynx                                     | 0.52 (0.21–1.32)            | 0.169                                                                    | 0.50 (0.17–1.47) |
| Nasopharynx                                    | 0.92 (0.57–1.48)            | 0.719                                                                    | 0.61 (0.32–1.16) |
| Hypopharynx                                    | 0.97 (0.45–2.11)            | 0.945                                                                    | 0.65 (0.25–1.73) |
| Oesophagus                                     | 0.66 (0.41–1.08)            | 0.098                                                                    | 0.40 (0.20–0.78) |
| Stomach                                        | 0.93 (0.61–1.43)            | 0.755                                                                    | 0.57 (0.32–1.02) |
| Small Intestine                                | 0.44 (0.22–0.86)            | 0.016                                                                    | 0.28 (0.10–0.77) |
| Colon                                          | 0.76 (0.50–1.15)            | 0.195                                                                    | 0.55 (0.31–0.98) |

(Continued)
| Variable | Relative Risk Ratio (95% CI) |
|----------|-------------------------------|
| **More than one primary site** | **Secondary Cancer Site** |
| Bone metastases | 1.16 (0.96–1.40) | 0.39 (0.30–0.50) |
| Liver metastases | 1.37 (1.14–1.64) | 0.09 (0.02–0.43) |
| Bone metastases | 1.25 (1.03–1.51) | 0.02 (0.01–0.23) |

(Continued)
US, Canada and Europe suggesting that low socioeconomic position is a risk factor for hospital deaths. [37] We hypothesize that within Singapore’s healthcare system, early transfers to LTC or hospice were taking place for low SES patients when they lose the ability to self-care, resulting in higher proportions of death within these institutions. [53] While palliative care services are routinely provided within hospices, many LTC facilities are still unable to provide good quality palliative care services due to manpower and resource constraints and lack of training [40] Palliative care provision has to be strengthened within LTC to meet the needs of the socially disadvantaged who are more likely to die in such facilities. [54–56]

We found home palliative care involvement to be associated with increased likelihood of home or LTC deaths. This concurs with meta-analysis evidence that home palliative care increases the likelihood of dying at home. [57] Our findings reaffirm ongoing national efforts in improving capacity of community palliative care to meet the needs of patients and facilitating out-of-hospital deaths. [40]

We found positive association between haematological malignancies and dying in hospital, echoing findings from studies done by western counterparts. [30,58–60] Additionally, this association remained strongly significant for almost all types of haematological malignancies. We postulate this is due to characteristics of underlying disease and treatment, including uncertain trajectories, indistinct transitions, prognostic difficulties and difficult symptoms (e.g. overwhelming sepsis, symptomatic anaemia, etc). [61] Referrals to palliative care occur less frequently for patients with haematological malignancies and often late in the disease trajectory, with many still undergoing aggressive treatment. [62] More research is needed to improve end-of-life outcomes for this group of patients.

Lastly, ethnicity was associated with place of death, suggesting that unmeasured sociocultural differences in perspectives influence utilization of hospice/LTC facilities. Malays were more likely to die at home, congruent with previous studies, possibly due to strong family and intergenerational support as well as religious beliefs. [63,64] In contrast, Indian and “other” (non-Chinese, non-Malay, non-Indian) minority ethnicities, compared to the Chinese, were more likely to die in hospital than in hospice or LTC. Additional studies with qualitative methodology may shed further light on this finding.

### Table 2.

| Variable                      | Relative Risk Ratio (95% CI) | Base category for places of death in multimonial logistic model = Hospital |
|-------------------------------|-----------------------------|--------------------------------------------------------------------------|
|                               | Home | P value | Hospice | P value | LTC | P value |
| Brain metastases              | 2.01 (1.62–2.49)            | <0.001                      | 2.53 (1.91–3.34)            | <0.001                      | 1.86 (1.28–2.70) | 0.001                      |
| Other metastases              | 1.00 (0.87–1.16)            | 0.986                      | 1.07 (0.89–1.28)            | 0.487                      | 1.03 (0.80–1.33) | 0.455                      |
| More than one secondary site  | 0.94 (0.81–1.09)            | 0.408                      | 0.77 (0.62–0.95)            | 0.013                      | 0.89 (0.68–1.17) | 0.408                      |

Abbreviations: LTC, Long-Term Care Facilities; ref, reference category; CCI, Charlson Comorbidity Index excluding cancer; Medifund, Medical Endowment Fund Scheme; CHAS, Community Health Assist Scheme; NHL, non-Hodgkin’s lymphoma; TCL: T-cell lymphomas; misc, miscellaneous; IPD, immunoproliferative diseases; MPCN, malignant plasma cell neoplasms.

a Included condominiums and landed properties
b To another tertiary healthcare institution
c Discharged against advice or abscondment
d Refer to Table 1 for the ICD-10-CM topography codes for each category of cancer site

* Not estimable as there were no decedent in the category
Note: RRR estimates in bold are significantly different from value 1 (p<0.05).

* Caution with interpretation due to low cell counts

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Strengths and limitations

A key strength of our study is the linkage of nation-wide clinical data with socioeconomic profiles and healthcare utilization data. Analysing place of death outcomes as a multiclass problem prevents oversimplification to a binary outcome of “hospital” vs “others” as individuals may prefer to die in other settings and understanding the factors influencing each is important. Additionally, only a small percentage of our cohort had missing data.

One key limitation was the inability to capture important variables such as patient preferences for place of death, acute hospital utilization at end-of-life, cancer stage at death, health and function trajectories and additional socioeconomic variables such as employment status, education level and caregiver burden. As this study was limited to public hospitals, we could not capture those who received treatment solely in private centres. However, majority of healthcare in Singapore is provided by public hospitals so the effect may be minimal. While some of the patients in our study may have died of other unrelated causes, this was mitigated by adjustment for comorbidity index at the time of index admission. Moreover, 91.26% of our cohort passed away from cancer as primary cause of death.

Finally, due to cancer epidemiology and the relatively small population in Singapore, the rarer cancers (e.g. bone, anus, female and male genital, Hodgkin’s disease) had low counts and hence the related statistics must be interpreted with caution.

Implications and generalisability

Results from our study suggest directions for future studies and healthcare policies. Firstly, low SES patients are more likely to die in LTC or hospice than hospitals. Provision of good quality palliative care should expand towards LTC to meet the needs of socially disadvantaged patients who are more likely to die in such facilities. Secondly, patients on home palliative care were more likely to pass away at home or in LTC, reaffirming efforts on improving capacity of community palliative care to meet the needs of patients and facilitating out-of-hospital-deaths. Thirdly, if patients with haematological cancers are more likely to pass away in hospitals, then it is essential that adequate care is available within the hospital setting. Additionally, research is needed on their care preferences, reasons for hospital deaths and mitigation strategies if home death is preferred by these patients.

Considering the similarity of some of our study findings to international studies, the findings may be generalizable to other urban settings. However, culture and system-specific factors found in our study highlight the complexities of place of death.

Conclusion

We found in this study key sociodemographic and clinical factors associated with non-hospital deaths among cancer patients. We believe our findings have implications for future policy making. High-risk groups for dying in hospitals may benefit from targeted models of care while better support can be tailored for those who pass away out of hospitals.

Supporting information

S1 Table. Cancer sites of decedents by place of death.

(DOCX)
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