RESEARCH ARTICLE

Duration of palliative care before death in international routine practice: a systematic review and meta-analysis

Roberta I. Jordan1†, Matthew J. Allsop1*†, Yousuf ElMokhallalati1, Catriona E. Jackson2, Helen L. Edwards1, Emma J. Chapman1, Luc Deliens3,4 and Michael I. Bennett1

Abstract

Background: Early provision of palliative care, at least 3–4 months before death, can improve patient quality of life and reduce burdensome treatments and financial costs. However, there is wide variation in the duration of palliative care received before death reported across the research literature. This study aims to determine the duration of time from initiation of palliative care to death for adults receiving palliative care across the international literature.

Methods: We conducted a systematic review and meta-analysis that was registered with PROSPERO (CRD42018094718). Six databases were searched for articles published between Jan 1, 2013, and Dec 31, 2018: MEDLINE, Embase, CINAHL, Global Health, Web of Science and The Cochrane Library, as well undertaking citation list searches. Following PRISMA guidelines, articles were screened using inclusion (any study design reporting duration from initiation to death in adults palliative care services) and exclusion (paediatric/non-English language studies, trials influencing the timing of palliative care) criteria. Quality appraisal was completed using Hawker’s criteria and the main outcome was the duration of palliative care (median/mean days from initiation to death).

Results: One hundred sixty-nine studies from 23 countries were included, involving 11,996,479 patients. Prior to death, the median duration from initiation of palliative care to death was 18.9 days (IQR 0.1), weighted by the number of participants. Significant differences between duration were found by disease type (15 days for cancer vs 6 days for non-cancer conditions), service type (19 days for specialist palliative care unit, 20 days for community/home care, and 6 days for general hospital ward) and development index of countries (18.91 days for very high development vs 34 days for all other levels of development). Forty-three per cent of studies were rated as ‘good’ quality. Limitations include a preponderance of data from high-income countries, with unclear implications for low- and middle-income countries.

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Conclusions: Duration of palliative care is much shorter than the 3–4 months of input by a multidisciplinary team necessary in order for the full benefits of palliative care to be realised. Furthermore, the findings highlight inequity in access across patient, service and country characteristics. We welcome more consistent terminology and methodology in the assessment of duration of palliative care from all countries, alongside increased reporting from less-developed settings, to inform benchmarking, service evaluation and quality improvement.

Keywords: Palliative care, Health services accessibility, Hospice care, Duration of care, Systematic review

Background
Palliative care aims to improve the quality of life of patients with life-limiting illnesses through prevention and relief of suffering [1]. Recent systematic reviews and meta-analyses demonstrate that early integration of specialist palliative care can improve quality of life for patients with advanced, incurable illness, including reducing symptom intensity, hospitalisation, aggressive treatments and associated costs at the end of life [2–4]. Studies included patients with malignant and non-malignant disease. Definitions of early integration vary. Although there is a paucity of well-conducted randomised controlled trials (RCTs) with mixed findings across trials, evidence suggests that ‘for full benefits of palliative care to be realised, continuity by a multidisciplinary team is needed for at least 3–4 months’ [5] to realise maximum benefit.

The 2018 Lancet Commission on Palliative Care and Pain Relief identified a lack of palliative care and pain relief globally [6]. By 2060, the burden of serious health-related suffering is expected to increase almost twofold, most rapidly in low-income countries [7]. Studies reporting on the duration of palliative care vary (e.g. from a median of 18–57 days and mean of 30–70 days), and suggest that early integration is not routine practice [8–19].

To date, there have been no attempts to systematically summarise reports on the duration of palliative care across the research literature. Doing so with a global focus could allow local and national services to benchmark using an international standard, determine country variations reflecting differences in wealth and palliative care development, and would identify the gap between current routine practice and the ideal duration of 3–4 months of palliative care.

This systematic review aims to identify studies reporting on the time interval between initiation of specialised palliative care services and death for adult patients within routine clinical practice and to explore associated patient, service and country characteristics which influence this duration.

Methods
We conducted a systematic review and meta-analysis. The study protocol was registered with PROSPERO (CRD42018094718) on 30 April 2018. Ethics approval was not required for this secondary data analysis.

Data sources and searches
Databases searched included MEDLINE (1946 to January 2019), Embase (1947 to January 2019), CINAHL (1960 to January 2019), Global Health (1973 to January 2019), Web of Science (1990 to January 2019) and The Cochrane Library. We conducted database searches on 2 October 2017 with additional updates on 12 February 2018 and 15 January 2019. The search strategy included terms for palliative care, duration of palliative care and referral (see example MEDLINE strategy provided in Additional file 1: Fig S1). Additional studies were identified through hand-searching of reference and citation lists of included studies. Search strategies (e.g. Additional file 1: Fig S1) were used to conduct a scoping search in October 2020 to determine whether any eligible population-based or large-scale studies had been published since January 2019. Of the 667 abstracts identified, no eligible population-based or large studies were identified so an updated extraction and analysis including data from 2019 was not undertaken.

Study selection
Studies were included if they reported on adult patients (≥18 years old) referred to or admitted under adult palliative care services. Palliative care services were defined as healthcare services which either self-define as specialist palliative care services or solely or majorly practise palliative care. These services could be in any setting including general hospital wards, specialist inpatient units/hospices or community settings (outpatients/day units/home care). Studies were only included if they reported length-of-stay in a specialist inpatient palliative care unit, referral-to-death time interval in any setting or survival time after palliative care referral. We limited search results to studies published from 1 January 2013 to 31 December 2018 to reflect contemporary practice. Included studies could be of any study design. Unpublished study data were included after contact with study investigators. Studies were excluded if they included children (<18 years old) or referrals to paediatric palliative care services and did not report adult data separately, reported
on referrals solely to bereavement services or non-palliative care services, were randomised trials where the intervention influenced the timing of palliative care or were not in the English language.

### Data extraction and quality assessment

Three authors (RIJ/CEJ/HLE) independently screened 10% of the titles and abstracts of studies identified. Discrepancies in screening inclusion and exclusion were resolved through discussion, and then review by a fourth author (MJA). As concordance between authors was greater than 90%, each author screened a portion of the remaining abstracts alone (assigned randomly and evenly distributed). Full-text articles were assessed for eligibility and, if included, data extraction was performed using a piloted form by three independent authors (RIJ/YE/HLE).

Data were extracted from each study on the following sample and methodological characteristics: country of origin, country level of human development according to the UNDP Development Index, country palliative care development level according to the WHPCA categorisation of palliative care development, study design, number of patients, percentage of patients alive at the end of the study period, summaries of age, gender and ethnicity (% White Caucasian) of study participants, each cohort’s type of disease, type of palliative care service referred to, the geographical level of analysis for each study (local, regional, national, international), the statistical summary of duration in days (mean, median or both) and terminology used to describe the duration of palliative care (survival, referral-to-death, length of stay). We extracted data on the primary outcome of the duration of palliative care before death in days (median or mean). Included study authors were contacted for missing data. Study quality of individual studies was assessed using Hawker’s criteria for reviewing disparate observational data systematically [20]. The criteria consist of 9 items, each with a score of 1–4 (total score of 36). We rated studies with scores of ≤18 as poor, 19–27 as fair and >27 as good, consistent with Boer et al.’s approach [21]. Four authors piloted the criteria with 10% of the included studies, with concordance of >90% achieved prior to individual allocation of remaining studies (RIJ/MJA/YE/EJC).

### Data synthesis and analysis

A meta-analysis was performed to synthesise reporting of the median number of days palliative care was initiated prior to death. We used the median as the preferred measure of central tendency as it is less affected by outliers and better reflects skewed data. The number of days from palliative care initiation to death was reported across the included articles in one of three ways: as a median, as a mean or including both a median and mean value. For studies reporting mean values only, linear regression modelling was used to derive a median value (see Additional file 1: Fig S2). This was calculated through examining the relationship between mean and median values in articles where both values were reported. The trend line was then applied to derive median values where included studies only reported a mean number of days from palliative care initiation to death. We then weighted median values for each study according to the number of study participants it contained. We then combined median values from all studies to calculate a final weighted median value and the interquartile range (IQR) to summarise duration of palliative care.

Additional analyses were performed to investigate the impact of country level of human development (United Nations Development Programme Human Development Index categories of very high, high, medium, low, other), country level of palliative care development (Worldwide Hospice Palliative Care Alliance 2011 categorisation of palliative care development using 1, 2, 3a, 3b, 4a, 4b), type of disease (malignant, non-malignant, mixed) and type of setting of the palliative care service (specialist palliative care unit, community/home, combined, general hospital ward, unspecified) on the duration of palliative care. We used the Mann-Whitney U test to compare the distribution of medians using a significance level of \( p = 0.05 \).

Sensitivity analyses were performed to assess the robustness of the primary outcome. Sensitivity analyses were undertaken to determine the impact of the characteristics of included studies on the overall weighted median duration of palliative care derived from all studies. A number of characteristics were identified for sensitivity analysis. These included studies where the mean duration of palliative care had been converted to a median value, studies with small sample sizes (<100 participants), studies analysing local and regional data (defined as ≥1 centres in the same geographical region within one country), studies reporting >5% survival at the end of the study period, studies reporting length-of-stay in palliative care units and studies with poor/fair ratings for methodological quality. For each characteristic included in the sensitivity analyses, we identified all studies with the characteristic of interest (e.g. studies with small sample sizes <100 participants), removed data from all studies with the characteristic, and then recalculated the final weighted median value with interquartile range (IQR) and median absolute deviation (MAD) to summarise duration of palliative care less the data from studies with the characteristic being explored. This enabled us to explore the influence of characteristics of interest on the overall weighted median duration of palliative care. We also conducted a post hoc analysis excluding the USA (United States of America) studies,
given differences found between studies from and outside of the USA.

We used IBM SPSS Statistics 22 for data analysis. Reporting is aligned with the PRISMA checklist for reporting systematic reviews and meta-analyses (see Additional file 2: Table S1).

Results

Two thousand six hundred sixty studies were screened, with 169 studies included in the systematic review and meta-analysis. Studies were excluded at the screening stage as their titles/abstracts did not meet the inclusion criteria broadly. Reasons for exclusion at the final eligibility stage are outlined in Fig. 1.

Table 1 summarises the individual characteristics of the included studies. All included studies were used in the meta-analysis.

A table summarising study characteristics can be found in Additional file 2: Table S1. The total number of study participants was 11,996,479. Eighty-eight per cent of studies were observational and retrospective, and most studies were descriptive rather than analytical. The source of publications was predominantly the USA, which accounted for 85% of studies and 97% of participants. Most studies (and 99% of participants) were from very high development countries (94%) and those with the greatest level (4b) of palliative care development (83%). Patients had a weighted mean age of 81.7 years with an equal distribution of males-to-females. Ethnicity was only reported in 38% of studies, stating 88% of study participants as white Caucasian. Most studies reported patients with malignant (50%) or non-malignant disease (12%). However, studies that reported a combined case-mix (35%) covered 91% of total participants. Similarly, half of the studies reported on specific types of palliative care service.
Table 1  Overview of the key characteristics of articles included the review

| Study author and citation | Country | UNDP HDI | WHPCA palliative care development | Study design | No. of patients | % patients alive at end of study period | Age (Mean) | Gender (% female) | Ethnicity (% White Caucasian) | Type of disease | Type of palliative care service | Level of analysis | Duration of palliative care (days) | Statistical summary reported | Terminology used to report duration of palliative care | Hawker's criteria rating (score) |
|---------------------------|---------|----------|-----------------------------------|--------------|----------------|----------------------------------------|------------|------------------|-------------------------------|----------------|-------------------------------|-----------------|-------------------------------|-----------------------------|--------------------------------|-----------------------------|
| Aeckerle, 2013 [22]       | Germany | Very high| 4b RO                             | 225          | 9%             | 60*                                    | 100%       | U                | Malignant                     | SPCU           | Local                          | Median Survival   | 59*                           | Median Survival            | Fair (26)                                 |
| Alsirafy, 2013 [23]       | Egypt   | Medium   | 3a RO                             | 123          | 0%             | 57*                                    | 5.7%       | U                | Malignant                     | SPCU           | Local                          | Median Survival   | 66*                           | Median Survival            | Fair (23)                                 |
| Bakitas, 2013 [24]        | USA     | Very high| 4b RO                             | 132          | 13%            | 76*                                    | 4.7%       | 98%              | Non-malignant                 | Combined       | Local                          | Median Survival   | 21*                           | Median Referral-to-death | Fair (26)                                 |
| Beernaert, 2013 [25]      | Belgium | Very high| 4b RO                             | 577          | 0%             | U                                      | 51%        | U                | Mixed                         | Combined       | National                       | Median Survival   | 1795*                          | Median Referral-to-death | Fair (27)                                 |
| Cheung, 2013 [26]         | USA     | Very high| 4b RO                             | 5420         | 0%             | 82*                                    | 7.2%       | 95%              | Mixed                         | SPCU           | National                       | Median Survival   | 1767*                          | Median Referral-to-death | Good (29)                                 |
| Corbett, 2013 [27]        | Australia| Very high| 4b PO                             | 276          | 46%            | 61*                                    | 4.2%       | U                | Malignant                     | Combined       | Local                          | Median Survival   | 34*                           | Median Referral-to-death | Fair (22)                                 |
| D'Angelo, 2013 [28]       | Italy   | Very high| 4b RO                             | 5320         | 9%             | 74*                                    | 50%        | U                | Malignant                     | Combined       | Local                          | Median Survival   | 21*, 38.8                        | Median Survival            | Fair (27)                                 |
| Dong, 2013 [29]           | USA     | Very high| 4b PO                             | 423          | 17%            | 73*                                    | 60%        | U                | Mixed                         | SPCU           | Regional                       | Median Survival   | 95.44*                         | Mean Referral-to-death | Good (28)                                 |
| Eli, 2013 [30]            | USA     | Very high| 4b PO                             | 1837         | 73%            | 70*                                    | 60%        | U                | Mixed                         | SPCU           | Local                          | Median Survival   | 4*                            | Median Length-of-stay       | Fair (24)                                 |
| Gerber, 2013 [31]         | USA     | Very high| 4b PO                             | 48           | U              | U                                      | U          | U                | Unspecified                   | SPCU           | Local                          | Median Survival   | 7*                            | Median Length-of-stay       | Poor (15)                                 |
| Harris, 2013 [32]         | USA     | Very high| 4b RO                             | 8669         | 0%             | 75*                                    | 5%         | U                | Mixed                         | SPCU           | Regional                       | Median Survival   | 31*                           | Median Length-of-stay       | Fair (24)                                 |
| Hussain, 2013 [33]        | UK      | Very high| 4b RO                             | 62           | 0%             | 62*                                    | 50%        | 100%             | Non-malignant                 | Community/home | Local                          | Median Survival   | 336*                          | Median Referral-to-death | Good (32)                                 |
| Kelley, 2013 [34]         | USA     | Very high| 4b PO                             | 1064         | 0%             | 84*                                    | 5.4%       | 85%              | Mixed                         | SPCU           | National                       | Median Survival   | 49*                           | Median Length-of-stay       | Fair (26)                                 |
| Mack, 2013 [35]           | USA     | Very high| 4b RO                             | 24226        | ≤ 10%           | U                                      | 48%        | U                | Malignant                     | Combined       | National                       | Median Survival   | 1553*, 4508*                   | Mean Referral-to-death | Good (28)                                 |
| Meng, 2013 [36]           | USA     | Very high| 4b RO                             | 136          | 0%             | 83*                                    | 78%        | 70%              | Mixed                         | SPCU           | Regional                       | Median Survival   | 15*, 47.9                     | Median Length-of-stay       | Good (29)                                 |
| Meradomt, 2013 [37]       | Italy   | Very high| 4b PO                             | 236          | 14%            | 73*                                    | 50%        | U                | Malignant                     | SPCU           | Regional                       | Mean Survival      | 184*                          | Mean Length-of-stay       | Fair (26)                                 |
| Nabul, 2013 [38]          | Spain   | Very high| 4a PO                             | 698          | 26%            | 74*                                    | 40%        | U                | Malignant                     | Community/home | Regional                       | Mean Survival      | 61*                           | Mean Referral-to-death       | Good (28)                                 |
| Nevdunskyi, 2013 [39]     | USA     | Very high| 4b RO                             | 49           | 0%             | 61*                                    | U          | 35%              | Malignant                     | Combined       | Local                          | Median Survival   | 16*                           | Median Referral-to-death | Fair (26)                                 |
| Pattenden, 2013 [40]      | UK      | Very high| 4b PO                             | 80           | 6%             | 81*                                    | 39%        | 91%              | Non-malignant                 | Community/home | National                       | Median Survival   | 41.41*                         | Median Survival            | Good (29)                                 |
| Redahan, 2013 [41]        | Ireland | Very high| 4b RO                             | 48           | 0%             | 64*                                    | 3.3%       | U                | Non-malignant                 | SPCU           | Local                          | Median Survival   | 12*                           | Median Referral-to-death | Fair (26)                                 |
Table 1 Overview of the key characteristics of articles included in the review (Continued)

| Study author and citation | Country | UNDP HDI | WHPCA palliative care development | Study design | No. of patients | % patients alive at end of study period | Age (Yrs) | Gender (% female) | Ethnicity (% White Caucasian) | Type of disease | Type of palliative care service | Level of analysis | Duration of palliative care (days) | Statistical summary reported | Terminology used to report duration of palliative care | Hawker’s criteria rating (score) |
|---------------------------|---------|----------|----------------------------------|-------------|----------------|----------------------------------------|-----------|------------------|---------------------------------|----------------|-----------------------------|----------------|-------------------------------|-----------------------------|---------------------------------|-----------------------------|
| Sengupta, 2013 [42]       | USA     | Very high | 4b RO                        | 4375 U      | U              | 45%                                   | 91%       | U                | U                               | Mixed          | Combined                    | National                  | 16.2*, 65.3‡                  | Median and mean                | Referral-to-death                  | Fair (19)                      |
| Speer, 2013 [43]          | USA     | Very high | 4b RO                        | 279 0%      | 81*           | 56%                                   | 34%       |                                      | Non-malignant                   | Mixed          | Community/ home             | Local                      | 16*                          | Median                        | Referral-to-death                  | Fair (22)                      |
| Wallace, 2013 [44]        | Ireland | Very high | 4b RO                        | 92 22%      | 77*           | 65%                                   | U         | Non-malignant                     | General hospital ward                  | Mixed          | General hospital ward       | Local                      | 13.16‡                         | Mean                           | Referral-to-death                  | Good (28)                      |
| Weckmann, 2013 [45]       | USA     | Very high | 4b RO                        | 98 0%       | U U           | U U                                   | Mixed     | Local                           | General hospital ward                  | Combined        | Community/ home             | Local                      | 77*                          | Median                        | Referral-to-death                  | Fair (21)                      |
| Zdankowski, 2013 [46]     | Australia | Very high | 4b RO                        | 550 33%      | 64*           | 50%‡                                   | U         | Malignant                       | Combined                      | Local                  | Community/ home             | Regional                  | 77*                          | Median                        | Referral-to-death                  | Fair (27)                      |
| Zheng, 2013 [47]          | USA     | Very high | 4b RO                        | 817 0%      | 83‡           | 70%‡                                   | 89%       | Mixed                           | Community/ home             | Local                  | Community/ home             | Regional                  | 235*, 93‡                    | Median and mean                | Referral-to-death                  | Fair (26)                      |
| Bogasky, 2014 [48]        | USA     | Very high | 4b RO                        | 3,008, 137  | 17%           | U                                      | 58%       | Mixed                          | Combined                      | National              | General hospital ward       | Local                      | 92*, 83‡                     | Median and mean                | Referral-to-death                  | Fair (25)                      |
| Brown, 2014 [49]          | USA     | Very high | 4b RO                        | 144 0%      | 60*          | 100%                                   | 69% §      | Malignant                       | Combined                      | Local                  | Community/ home             | Regional                  | 355*                         | Median                        | Referral-to-death                  | Good (30)                      |
| Casarett, 2014 [50]       | USA     | Very high | 4b RO                        | 49,370 16%  | 79*           | 56%                                   | 89%       | Mixed                           | SPCU                          | Regional              | General hospital ward       | Local                      | 24.74*                       | Mean                           | Referral-to-death                  | Good (29)                      |
| Choi, 2014 [51]           | Canada  | Very high | 4b PO                        | 129 0%      | 71*           | 55%                                   | U         | Malignant                       | Community/ home             | Local                  | Community/ home             | Local                      | 92*, 145.85‡                   | Median and mean                | Referral-to-death                  | Fair (27)                      |
| Eastman, 2014 [52]        | Australia | Very high | 4b RO                        | 6004 35%    | U U           | U U                                   | Mixed     | Unspecified                     | SPCU                          | Regional              | General hospital ward       | Local                      | 128‡                         | Mean                           | Referral-to-death                  | Fair (24)                      |
| Fullerton, 2014 [53]      | Australia | Very high | 4b RO                        | 38 11%      | U U           | U U                                   | Mixed     | Unspecified                     | SPCU                          | Local                  | General hospital ward       | Regional                  | 151*                         | Mean                           | Referral-to-death                  | Poor (13)                      |
| Guay, 2014 [54]           | USA     | Very high | 4b RO                        | 435 U       | 57*           | 54%                                   | 62%       | Malignant                       | Community/ home             | Local                  | Community/ home             | Local                      | 214.91*‡                     | Median                        | Survival                      | Good (29)                      |
| Hui, 2014 [55]            | USA     | Very high | 4b RO                        | 368 0%      | 60*           | 52%                                   | 62%       | Malignant                       | Combined                      | Local                  | Community/ home             | Local                      | 623.3*‡                       | Median                        | Referral-to-death                  | Good (31)                      |
| Kang, 2014 [56]           | Taiwan  | Very high | 4a RO                        | 2154 32%    | 74*           | 49%                                   | U         | Mixed                          | SPCU                          | National              | General hospital ward       | Regional                  | 1041*†                       | Mean                           | Referral-to-death                  | Fair (26)                      |
| Kao, 2014 [57]            | Taiwan  | Very high | 4a RO                        | 2020 15%    | 58*           | 41%                                   | U         | Malignant                       | General hospital ward       | Regional              | General hospital ward       | Local                      | 128*                         | Mean                           | Referral-to-death                  | Good (29)                      |
| Keim-Malpass, 2014 [58]   | USA     | Very high | 4b RO                        | 30 0%       | 31*           | 51%‡                                   | 79%‡       | Malignant                       | General hospital ward       | Local                  | General hospital ward       | Local                      | 32‡                          | Mean                           | Referral-to-death                  | Good (29)                      |
| Koivu, 2014 [59]          | Finland | Very high | 4a RO                        | 138 0%      | 75*           | 64%                                   | U         | Malignant                       | SPCU                          | Regional              | SPCU                      | Local                      | 3.2                          | Mean                           | Referral-to-death                  | Fair (23)                      |
Table 1 Overview of the key characteristics of articles included the review (Continued)

| Study author and citation | Country        | UNDP HDI level | Study design | WHPCA palliative care development | No. of patients | % patients alive at end of study period | Age (years) | Gender (% female) | Ethnicity (% White Caucasian) | Type of disease | Type of palliative care service | Level of analysis | Duration of palliative care (days) | Statistical summary reported | Terminology used to report duration of palliative care | Hawker’s criteria rating (score) |
|---------------------------|----------------|----------------|--------------|-----------------------------------|----------------|----------------------------------------|-------------|-------------------|-----------------------------|----------------|-----------------------------|----------------|-------------------------------|------------------------|--------------------------------|-----------------------------|
| Obermeyer, 2014 [60]      | USA            | Very high      | 4b           | RO                                | 18,165         | 0%                                     | 80          | 5.2%              | 89%                         | Malignant       | Combined                    | National         | 11*                          | Median                | Length-of-stay                  | Good (26)               |
| Olmsted, 2014 [61]        | USA            | Very high      | 4b           | RO                                | 77,267         | 0%                                     | U           | 2%*              | 71%*                       | Mixed           | Combined                    | National         | 23.63*                       | Median                | Referral-to-death               | Good (29)                |
| Scheffey, 2014 [62]       | USA            | Very high      | 4b           | RO                                | 1,368          | 0%                                     | U           | U                 | U                           | Mixed           | SPCU                        | Regional         | 15*                          | Median                | Length-of-stay                  | Fair (25)                |
| Seow, 2014 [63]           | Canada         | Very high      | 4b           | RO                                | 3,912          | 0%                                     | 75*         | 5.2%              | U                           | Mixed           | Community/ home               | Regional         | 73*                          | Mean                 | Length-of-stay                  | Fair (26)                |
| Sexauer, 2014 [64]        | USA            | Very high      | 4b           | RO                                | 53             | 0%                                     | 64*         | 5.1%              | U                           | Malignant       | Combined                    | Local            | 7.98*                        | Median                | Length-of-stay                  | Fair (27)                |
| Shin, 2014 [65]           | USA            | Very high      | 4b           | RO                                | 610            | 20%                                     | 59*         | 4.7%              | 66%                         | Malignant       | SPCU                        | Local            | 32.53*; 8*                    | Median and mean         | Survival                       | Good (29)                |
| Unroe, 2014 [66]          | USA            | Very high      | 4b           | RO                                | 3,771          | 17%                                     | 70*         | 5.9%              | 62%                         | Mixed           | Combined                    | National         | 22*; 84.5*                   | Median and mean         | Referral-to-death               | Poor (17)                |
| Wachterman, 2014 [67]     | USA            | Very high      | 4b           | RO                                | 1,415          | 16%                                     | 75*         | 0%                | 82%                         | Mixed           | Combined                    | National         | 16.71*                       | Median                | Referral-to-death               | Good (29)                |
| Yamagishi, 2014 [68]      | Japan          | Very high      | 4b           | RO                                | 693            | 0%                                     | 72*         | 40%               | U                           | Malignant       | Community/ home               | National         | 35*                          | Median                | Referral-to-death               | Good (29)                |
| Yeung, 2014 [69]          | USA            | Very high      | 4b           | RO                                | 6,982          | 0%                                     | U           | 49%               | 89%                         | Malignant       | SPCU                        | National         | 13*                          | Median                | Length-of-stay                  | Good (28)                |
| Alsiraﬁ, 2015 [70]       | Saudi Arabia   | Very high      | 3a           | RO                                | 328            | 0%                                     | U           | 50%               | U                           | Malignant       | Combined                    | Local            | 16.1*                        | Mean                  | Length-of-stay                  | Fair (23)                |
| Chiang, 2015 [71]         | Taiwan         | Very high      | 4a           | RO                                | 566            | 0%                                     | 69*         | 39%               | U                           | Malignant       | Combined                    | National         | 23*; 54.7*                   | Median and mean         | Referral-to-death               | Good (30)                |
| Choi, 2015 [72]           | South Korea    | Very high      | 3a           | RO                                | 84             | 0%                                     | 64*         | 35%               | 5%                          | Malignant       | SPCU                        | Local            | 12.33*; 26.25*               | Median and mean         | Length-of-stay                  | Fair (24)                |
| Colman, 2015 [73]         | Canada         | Very high      | 4b           | RO                                | 24             | 0%                                     | 57*         | 46%               | U                           | Mixed           | Combined                    | Local            | 14*                          | Median                | Referral-to-death               | Fair (25)                |
| Dingfeld, 2015 [74]       | USA            | Very high      | 4b           | RO                                | 12,5634        | 3%                                     | 78*         | 5.6%              | 87%                         | Malignant       | SPCU                        | National         | 53*                          | Mean                  | Length-of-stay                  | Good (30)                |
| Dougherty, 2015 [75]      | USA            | Very high      | 4b           | RO                                | 8,581          | 14%                                     | 74*         | 5.2%              | 88%                         | Malignant       | SPCU                        | National         | 79.57*                       | Mean                 | Referral-to-death               | Fair (26)                |
| El-Jawahri, 2015 [76]     | USA            | Very high      | 4b           | RO                                | 49             | 0%                                     | 70*         | 41%               | 97%                         | Malignant       | Combined                    | Regional         | 7*                          | Median                | Referral-to-death               | Fair (26)                |
| Gage, 2015 [77]           | UK             | Very high      | 4b           | RO                                | 688            | 0%                                     | 75*         | 4.4%              | U                           | Unspecified      | Combined                    | Regional         | 70.54*                       | Mean                 | Referral-to-death               | Good (30)                |
| Gozalo, 2015 [78]         | USA            | Very high      | 4b           | RO                                | 261,252        | U                                       | 85*         | 6.5%              | U                           | Malignant       | SPCU                        | National         | 1920*; 833.33*               | Median and mean         | Length-of-stay                  | Fair (22)                |
| Gu, 2015 [79]             | China          | High           | 4a           | RO                                | 244            | 0%                                     | 64*         | 4.9%              | U                           | Malignant       | SPCU                        | Local            | 19*; 23.54*                   | Median and mean         | Survival                      | Good (29)                |
| Study author and citation | Country | UNDP HDI | WHPCA palliative care development | Study design | No. of patients | % patients alive at end of study period | Age (median) | Gender (% female) | Ethnicity (% White Caucasian) | Type of disease | Type of palliative care service | Level of analysis | Duration of palliative care (days) | Statistical summary reported | Terminology used to report duration of palliative care | Hawker's criteria rating (score) |
|--------------------------|---------|----------|----------------------------------|--------------|----------------|----------------------------------------|-------------|------------------|-------------------------------|----------------|-------------------------------|----------------|---------------------------------|-----------------------------|---------------------------------|-------------------------|
| Gupte, 2015 [80]         | USA     | Very high | 4b RO                            | 1801         | U              | 72§                                   | 49%         | 9.3%             | Malignant                     | Combined        | National                      |                           | 21.81†, 6366‡†               | Median Length-of-stay          | Good (32)  |
| Hennemann-Krause, 2015 [81] | Brazil | High     | 3a PO                            | 12           | 0%             | 68δ                                   | 42%         | U                | Malignant                     | Community/ home | Local                          |                           | 193δ                   | Mean Referral-to-death           | Good (28)  |
| Hui, 2015 [82]           | Multicentre - USA and Brazil | Very high | 4b & 3a PO                       | 3.57        | 43%            | 58δ                                   | 5.5%        | U                | Malignant                     | SPCU Internatiional | 6*                           |                           | Median Length-of-stay           | Good (31)  |
| Koo, 2015 [83]           | Taiwan  | Very high | 4a RO                            | 462          | 0%             | 68δ                                   | 30%         | U                | Malignant                     | Combined National | 19*, 36.37†                   |                           | Mean Survival Referral-to-death | Good (31)  |
| Kim, 2015 [84]           | South Korea | Very high | 3a RO                            | 198          | 0%             | 66δ                                   | 41%         | U                | Malignant                     | SPCU Local        | 18*                           |                           | Median Length-of-stay           | Good (28)  |
| Kozlov, 2015 [85]        | USA     | Very high | 4b RO                            | 160          | 13%            | U                                     | U           | U                | Mixed                         | General hospital ward | Local                          |                           | 23*, 73.89§                  | Median Referral-to-death       | Fair (21)  |
| Lee, 2015 [86]           | South Korea | Very high | 3a RO                            | 609          | 0%             | U                                     | 52%         | U                | Malignant                     | SPCU Local        | 21*                           |                           | Median Survival              | Fair (24)  |
| Myers, 2015 [87]         | Canada  | Very high | 4b PO                            | 368          | 0%             | 65§                                   | 56%         | U                | Malignant                     | Community/ home | Local                          |                           | 121*, 171.7†                | Median Survival                | Fair (21)  |
| O'Connor, 2015 [88]      | USA     | Very high | 4b RO                            | 122          | 0%             | 55§                                   | 100%        | 76%              | Malignant                     | Combined Local     | 17*                           |                           | Median Referral-to-death       | Good (29)  |
| Pineau, 2015 [89]        | Canada  | Very high | 4b RO                            | 28           | 0%             | U                                     | U           | U                | Unspecified                   | SPCU Local        | 120§                          |                           | Mean Length-of-stay            | Poor (13)   |
| Zakhour, 2015 [90]       | USA     | Very high | 4b RO                            | 55           | 0%             | 7013                                   | 100%        | 79%              | Malignant                     | Combined Local     | 28*                           |                           | Median Referral-to-death       | Good (28)  |
| Bourman, 2016 [91]       | USA     | Very high | 4b RO                            | 46           | 0%             | 644§                                   | 68%         | 77%              | Malignant                     | Combined Local     | 96*                           |                           | Median Referral-to-death       | Fair (26)  |
| Bennett, 2016 [92]       | UK      | Very high | 4b RO                            | 4650         | 0%             | 75§                                   | 49%         | U                | Mixed                         | Combined Regional  | 34*                           |                           | Median Referral-to-death       | Good (29)  |
| Brooks, 2016 [93]        | USA     | Very high | 4b RO                            | 650          | 0%             | U                                     | 39%         | 73%              | Malignant                     | Combined National  | 2144§                          |                           | Median Referral-to-death       | Good (28)  |
| Brown, 2016 [94]         | USA     | Very high | 4b RO                            | 7,209        | U              | 7113                                   | 5.3%        | 81%              | Non-malignant                 | SPCU National     | 9*, 45§                        |                           | Median Length-of-stay           | Good (29)  |
| Cheraghliou, 2016 [95]   | USA     | Very high | 4b PO                            | 241          | 1%             | 88δ                                   | 6.5%        | 90%              | Mixed                         | Combined Regional  | 15*                           |                           | Median Referral-to-death       | Fair (26)  |
| Diamond, 2016 [96]       | USA     | Very high | 4b RO                            | 160          | U              | 63§                                   | 42%         | 62%              | Malignant                     | Community/ home | Local                          |                           | Mean Referral-to-death         | Good (30)  |
| Hamano, 2016 [97]        | Japan   | Very high | 4b PO                            | 2069         | 2%             | 70δ                                   | 42%         | U                | Malignant                     | Combined National  | 28*                           |                           | Median Survival               | Fair (26)  |
| Jairo, 2016 [98]         | USA     | Very high | 4b RO                            | 30,629       | 0%             | U                                     | 51%         | 81%              | Malignant                     | Combined National  | 18*                           |                           | Median Referral-to-death       | Good (31)  |
Table 1 Overview of the key characteristics of articles included the review (Continued)

| Study author and citation | Country | UNDP HDI | WHPCA palliative care development | Study design | No. of patients | % of patients alive at end of study period | Age (Years) | Gender (% female) | Ethnicity (% White Caucasian) | Type of disease | Type of palliative care service | Level of analysis | Duration of palliative care (days) | Statistical summary reported | Terminology used to report duration of palliative care | Hawker’s criteria rating (score) |
|---------------------------|---------|----------|----------------------------------|--------------|----------------|------------------------------------------|-------------|------------------|-------------------------------|---------------|------------------------------|-----------------|-------------------------------|-----------------------------|---------------------------------|--------------------------|
| Jagieł 2016 [98] USA     |         | Very high |                                  | RO           | 197            | 26%                                       | 66‡         | 3.7%             | 36%                           | Malignant      | SPCU                         | Local           | 4.86‡                          | Median Length-of-stay Good (1)                       |                                |                          |
| Kiefer, 2016 [99] Austria |        | Very high |                                  | RO           | 50             | 0%                                       | 62*         | 6.2%             | U                             | Malignant      | SPCU                         | Local           | 21*                           | Median Length-of-stay Fair (27)                      |                                |                          |
| King, 2016 [100] USA     |        | Very high |                                  | RO           | 158            | U                                       | 63*         | 5.5%             | U                             | Malignant      | SPCU                         | Local           | 30.24*                        | Median Length-of-stay Good (29)                      |                                |                          |
| Lowe, 2016 [101] Canada  |        | Very high |                                  | RO           | 2922           | 0%                                       | 73‡         | 4.7%             | U                             | Malignant      | Combined Regional              | Local           | 34*                           | Median Survival Good (29)                           |                                |                          |
| Masman, 2016 [102] Netherland |    | Very high |                                  | PO           | 58             | 47%                                       | 75*         | 5.5%             | U                             | Malignant      | SPCU                         | Local           | 36*                           | Median Length-of-stay Good (29)                      |                                |                          |
| Obermeyer, 2016 [103] USA |        | Very high |                                  | RO           | 254,729        | 0%                                       | 78*         | 5.0%             | U                             | Malignant      | Combined National              | Local           | 15*                           | Median Referral-to-death Fair (24)                   |                                |                          |
| Odejide, 2016 [104] USA  |        | Very high |                                  | RO           | 7810           | 0%                                       | 55%         | 93%              | U                             | Malignant      | Combined National              | Local           | 120.55*                        | Median Referral-to-death Fair (26)                   |                                |                          |
| Perri, 2016 [105] Canada |        | Very high |                                  | RO           | 235            | 4%                                       | 84*         | 5.4%             | U                             | Non-malignant  | SPCU                         | Local           | 30*                           | Mean Length-of-stay Fair (27)                         |                                |                          |
| Porteous, 2016 [106] UK  |        | Very high |                                  | RO           | 298            | 56%                                       | U           | 5.5%             | U                             | Malignant      | SPCU                         | Local           | 9*                            | Median Length-of-stay Good (28)                      |                                |                          |
| Rosenwax, 2016 [107] Australi a | | Very high |                                  | RO           | 5532           | 0%                                       | 70*         | 46%              | U                             | Malignant      | Combined Regional              | Local           | 25*                           | Median Referral-to-death Good (28)                   |                                |                          |
| Satthornvyissayang, 2016 [108] Thailand | | High |                                  | RO           | 317            | 28%                                       | 63*         | 4.9%             | U                             | Malignant      | Combined Local                 | Local           | 33*                           | Median Survival Good (29)                           |                                |                          |
| Schrøder, 2016 [109] Germany |       | Very high |                                  | PO           | 269            | 2%                                        | 70*         | 4.2%             | U                             | Malignant      | SPCU                         | Local           | 9*                            | Mean Length-of-stay Fair (27)                         |                                |                          |
| Schur, 2016 [110] Austr i a |        | Very high |                                  | RO           | 2414           | 0%                                       | 73*         | 5.2%             | U                             | Malignant      | Combined National              | Local           | 9*                            | Median Referral-to-death Fair (27)                   |                                |                          |
| Senderovitch, 2016 [111] Canada |       | Very high |                                  | RO           | 237            | U                                       | 79*         | 5.9%             | U                             | Malignant      | SPCU                         | Local           | 5.405*                         | Mean Length-of-stay Good (30)                      |                                |                          |
| Sharma, 2016 [112] USA  |        | Very high |                                  | RO           | 567            | 0%                                       | 70*         | 2.4%             | 94%                          | Malignant      | Combined Local                 | Local           | 22.14*                         | Mean Referral-to-death Fair (27)                   |                                |                          |
| Stevenson, 2016 [113] USA |        | Very high |                                  | RO           | 5,519, 8,49   | 19%                                       | 83*         | 5.9%             | 89%                          | Malignant      | Combined National              | Local           | 189.1* 82.19*                     | Median and mean Referral-to-death Good (29)             |                                |                          |
| United States Renal Data System, 2017 [114] USA | | Very high |                                  | RO           | 180,491        | 0%                                       | 69*         | 5.4%             | 67%                          | Non-malignant  | Combined National              | Local           | 5*                            | Median Referral-to-death Fair (19)                   |                                |                          |
| Ådersen, 2017 [115] Denmark |       | Very high |                                  | RO           | 21,597         | 0%                                       | 70*         | 5.0%             | U                             | Malignant      | Combined National              | Local           | 29*, 64.6*                      | Median and mean Referral-to-death Good (28)             |                                |                          |
| Chan, 2017 [116] UK      |        | Very high |                                  | RO           | 165            | 8%                                        | U           | U                | U                             | Malignant      | SPCU                         | Local           | 66*                           | Mean Length-of-stay Fair (20)                        |                                |                          |
| Choi, 2017 [117] South Korea |       | Very high |                                  | RO           | 1829           | 0%                                       | 51*         | 6.3%             | U                             | Malignant      | SPCU                         | National       | 262*                          | Mean Length-of-stay Fair (25)                        |                                |                          |
| Study author and citation | Country | UNDP HDI | WHPCA palliative care development | Study design | No. of patients | % patients alive at end of study period | Age (% female) | Ethnicity (% White Caucasian) | Type of disease | Type of palliative care service | Level of analysis | Duration of palliative care (days) | Statistical summary reported | Terminology used to report duration of palliative care | Hawker’s criteria rating (score) |
|---------------------------|---------|---------|----------------------------------|-------------|----------------|----------------------------------------|---------------|-----------------------------|----------------|-------------------------------|----------------|---------------------------------|------------------------|--------------------------------|---------------------------|
| de la Cruz, 2017 [118]    | USA     | Very high | 4b RO                          | 329        | 76%            | 56d 5.5% 6.3% | Malignant                  | SPCU          | Local                         | Mean           | 7.02*                          | Mean Length-of-stay | Fair (26)                     |                               |                           |
| Eirinse, 2017 [119]       | USA     | Very high | 4b RO                          | 66   0%     | 64e 28% 92%   | 72d 49% 86%   | Malignant                  | Combined      | Local                         | Median and mean | 93.24*, 144.12††               | Referral-to-death | Fair (26)                     |                               |                           |
| Forst, 2017 [120]         | USA     | Very high | 4b RO                          | 7849 0%    | 82d 60% 87%   | 81* 5.1% 8.2%  | Non-malignant              | Combined      | National                       | Median          | 4.10*††                        | Mean Referral-to-death | Good (28)                     |                               |                           |
| Fukui, 2017 [121]         | USA     | Very high | 4b RO                          | 37,165 15% | 82d 60% 87%   | 81* 5.1% 8.2%  | Non-malignant              | Combined      | National                       | Median          | 6.89*, 17.14††                 | Referral-to-death | Fair (27)                     |                               |                           |
| Harris, 2017 [122]        | USA     | Very high | 4b RO                          | 1972 0%    | 81* 5.1% 8.2%  | 81* 5.1% 8.2%  | Mixed                      | Combined      | National                       | Median          | 41.04††                        | Mean Referral-to-death | Fair (27)                     |                               |                           |
| Hoverman, 2017 [123]      | USA     | Very high | 4b PI                          | 345         | 0% U U U       | Malignant                  | SPCU          | Local                         | Median and mean | Mean Referral-to-death | Fair (20) |                               |                       |                           |
| Kaufman, 2017 [124]       | USA     | Very high | 4b RO                          | 1,248 23%  | 78d 5.4% 70%  | 72d 5.4% 70%   | Mixed                      | Combined      | National                       | Median          | 27*, 86ª                        | Referral-to-death | Fair (26)                     |                               |                           |
| Kelly, 2017 [125]         | USA     | Very high | 4b RO                          | 81         | 0% 59ª 35.º   | U Non-malignant  | Combined                  | Local          | 15*                           | Median          | Survival                      | Fair (27) |                               |                       |                           |
| Kuchinad, 2017 [126]      | USA     | Very high | 4b RO                          | 39         | 0% 62ª 36% 87% | U Malignant                  | Combined      | Local                         | median          | 9.33††                         | Mean Referral-to-death | Fair (26)                     |                               |                           |
| Lin, 2017 [127]           | Taiwan  | Very high | 4a RO                          | 22,270     | 0% 66ª 4.0% 87% | U Malignant                  | Combined      | National                       | Median          | 228*, 47.47††                 | Referral-to-death | Fair (22)                     |                               |                           |
| Lusbarder, 2017 [128]     | USA     | Very high | 4b RO                          | 293         | 0% 86ª 5.1% 93% | Mixed                      | Combined      | Regional                       | Median and mean | 228*, 47.47††                 | Referral-to-death | Fair (22)                     |                               |                           |
| Masel, 2017 [129]         | Austria | Very high | 4b RO                          | 91          | 25% 62ª 39%  U | Malignant                  | SPCU          | Local                         | Median          | 16*                           | Median Length-of-stay | Fair (25)                     |                               |                           |
| Merodiaante, 2017 [130]   | Italy   | Very high | 4b PO                          | 314         | 96% 66ª 4.2%  U | Malignant                  | SPCU          | Local                         | Mean           | 7.01††                        | Mean Length-of-stay | Good (25)                     |                               |                           |
| O’Leary, 2017 [17]        | Ireland | Very high | 4b RO                          | 507         | 0% U 50%  U    | Mixed                      | Combined      | Regional                       | Mean           | Referral-to-death | Good (28) |                               |                       |                           |
| Otsuka, 2017 [131]        | Japan   | Very high | 4b RO                          | 415         | 0% 72ª 40%  U | Malignant                  | Combined      | Local                         | Median          | 54*                            | Mean Referral-to-death | Fair (27)                     |                               |                           |
| Palmer, 2017 [132]        | USA     | Very high | 4b RO                          | 3704        | 0% U 5.9% 78% | Malignant                  | Combined      | Local                         | Median          | 17.5*                         | Median Length-of-stay | Fair (27)                     |                               |                           |
| Pellizzi, 2017 [133]      | Italy   | Very high | 4b RO                          | 2211        | 0% U 4.2%  U   | Malignant                  | Community/ home | Regional                      | Median          | 9.2*                          | Median Referral-to-death | Good (29)                     |                               |                           |
| Rivet, 2017 [134]         | USA     | Very high | 4b RO                          | 82          | 67% 60* U U    | Non-malignant              | General hospital ward | Local          | 1*                           | Median          | Referral-to-death | Good (30) |                               |                       |                           |
| Sandof, 2017 [135]        | USA     | Very high | 4b RO                          | 5056        | 0% 73* 3.1% 7.2% | Malignant                  | Combined      | National                       | Median          | 18*                           | Mean Referral-to-death | Fair (25)                     |                               |                           |
| Scaccabarozzi, 2017 [136] | Italy   | Very high | 4b RO                          | 1114        | 0% 76* 4.4%  U | Mixed                      | Combined      | Regional                       | Median          | 31*                           | Mean Referral-to-death | Fair (27)                     |                               |                           |
| Study author and citation | Country   | UNDP HDI | WHPCA palliative care development | Study design | No. of patients | % patients alive at end of study period | Age | Gender (% female) | Ethnicity (% White Caucasian) | Type of disease | Type of palliative care service | Level of analysis | Duration of palliative care (days) | Statistical summary reported | Terminology used to report duration of palliative care | Hawker’s criteria rating (score) |
|--------------------------|-----------|----------|-----------------------------------|--------------|----------------|----------------------------------------|-----|------------------|-------------------------------|----------------|----------------------------------|-----------------|-----------------------------------|-----------------------------|---------------------------------|---------------------------|
| Schuler, 2017 [137]      | USA       | Very high| 4b                                 | RO           | 7,590          | 7%                                     | U   | 51%             | 89%                           | Malignant       | Combined                         | National         | 12*                              | Median Referral-to-death       | Good (29)                     |
| Senel, 2017 [138]        | Turkey    | High     | 3b                                 | PO           | 213            | 44%                                    | 60% | 41%             | U                             | Malignant       | SPCU                             | Local            | 8.64*                           | Mean Length-of-stay            | Fair (27)                     |
| Shah, 2017 [139]         | Australia | Very high| 4b                                 | RO           | 74             | 11%                                    | 75% | 19%             | U                             | Malignant       | Unspecified                      | Local            | 1.79*                           | Median Survival              | Good (29)                     |
| Sharp, 2017 [140]        | UK        | Very high| 4b                                 | RO           | 108            | U                                       | 70% | 32%             | U                             | Non-malignant   | Combined                         | Local            | 1.24*                           | Median Referral-to-death       | Fair (23)                     |
| Tanuseputro, 2017 [19]   | Canada    | Very high| 4b                                 | RO           | 9,276          | 0%                                     | U   | 51%             | U                             | Mixed          | Combined                         | Regional         | 111.1*                          | Mean Referral-to-death         | Good (29)                     |
| Taylor, 2017 [141]       | USA       | Very high| 4b                                 | RO           | 2,642          | 0%                                     | U   | 77%             | 5%                            | Malignant       | Combined                         | Regional         | 20*                             | Median Referral-to-death       | Fair (27)                     |
| Unroe, 2017 [142]        | USA       | Very high| 4b                                 | RO           | 3,2605         | 15%                                    | 80% | 61%             | 75%                           | Mixed          | Community/ Home                   | National         | 20*, 70.4*                       | Median and mean Referral-to-death | Good (28)                     |
| Vayne-Bossert, 2017 [143]| Australia | Very high| 4b                                 | RO           | 62             | 0%                                     | 89% | U               | U                             | Malignant       | Combined                         | Local            | 103*                            | Median Referral-to-death       | Good (29)                     |
| Vinant, 2017 [144]       | France    | Very high| 4b                                 | PO           | 744            | 26%                                    | 72% | 48%             | U                             | Mixed          | Combined                         | Regional         | 22*                             | Median Survival               | Good (30)                     |
| Waite, 2017 [145]        | USA       | Very high| 4b                                 | RO           | 49             | 0%                                     | 78% | 51%             | 5%                            | Non-malignant   | General hospital ward             | Local            | 1.54*                           | Median Referral-to-death       | Fair (24)                     |
| Wang, Hsu, 2017 [146]    | USA       | Very high| 4b                                 | RO           | 7,184          | 0%                                     | 78% | 53%             | 87%                           | Malignant       | Combined                         | National         | 109*                            | Mean Referral-to-death         | Good (29)                     |
| Wang, Knight, 2017 [147] | USA       | Very high| 4b                                 | RO           | 394            | U                                       | U   | U               | U                             | Malignant       | Combined                         | Regional         | 145*, 31.6*                      | Median and mean Referral-to-death | Good (29)                     |
| Wilson, 2017 [148]       | USA       | Very high| 4b                                 | RO           | 28             | 0%                                     | 75% | 40%             | 5%                            | Non-malignant   | General hospital ward             | Local            | 0.42*                           | Median Referral-to-death       | Good (32)                     |
| Yim, 2017 [149]          | USA       | Very high| 4b                                 | RO           | 5073           | 9%                                     | 82% | 55%             | 87%                           | Non-malignant   | Combined                         | National         | 15*, 71*                         | Median and mean Referral-to-death | Fair (27)                     |
| Akdogan, 2018 [150]      | Turkey    | High     | 3b                                 | RO           | 305            | 57%                                    | 80% | 46%             | 75%                           | Non-malignant   | SPCU                             | Local            | 31.1*                           | Mean Length-of-stay            | Fair (26)                     |
| Allsop, 2018 [8]         | UK        | Very high| 4b                                 | RO           | 4,237          | 0%                                     | U   | 48%             | 75%                           | Malignant       | Combined                         | National         | 48*                             | Median Referral-to-death       | Good (30)                     |
| Assaeh, 2018 [151]       | Australia | Very high| 4b                                 | RO           | 24,468         | 0%                                     | U   | 49%             | 5%                            | Non-malignant   | General hospital ward             | Regional         | 6*, 7.6*                         | Median and mean Referral-to-death | Good (30)                     |
| Cho, 2018 [152]          | Singapore | Very high| 4b                                 | RO           | 25             | 0%                                     | 68% | 65%             | 5%                            | Non-malignant   | Combined                         | Local            | 8*                             | Median Referral-to-death       | Good (28)                     |
| Choi, 2018 [153]         | South Korea | Very high | 3a                              | RO           | 1829           | 0%                                     | 68% | 45%             | U                             | Malignant       | SPCU                             | National         | 262*                            | Mean Length-of-stay            | Good (30)                     |
Table 1  Overview of the key characteristics of articles included the review (Continued)

| Study author and citation | Country       | UNDP HDI | WHPCA palliative care development | Study design | No. of patients | % patients alive at end of study period | Age (years) | Gender (% female) | Ethnicity (% White Caucasian) | Type of disease | Type of palliative care service | Level of analysis | Duration of palliative care (days) | Statistical summary reported | Terminology used to report duration of palliative care | Hawker’s criteria rating (score) |
|---------------------------|---------------|----------|-----------------------------------|-------------|----------------|----------------------------------------|-------------|------------------|---------------------------------|----------------|-------------------------------|---------------------|------------------------------------|-------------------------------|---------------------------------|---------------------------|
| de Oliveira Valentino, 2018 [154] | Brazil   | High    | 3a                                 | RO          | 839            | 0%                                      | 62² 49%      | U                | Malignant              | Combined     | Local                          | 185.54*              | Mean                             | Referral-to-death            | Good (30)                        |
| Diço, 2018 [155]            | Turkey      | High    | 3b                                 | RO          | 85             | 46%                                     | 84² 55%      | U                | Non-malignant          | SPCU          | Local                          | 15*                 | Median                           | Length-of-stay                | Fair (26)                       |
| Duff, 2018 [156]            | USA         | Very high | 4b                                | RO          | 52             | 0%                                      | 66² 2%       | 75%              | Malignant              | Unspecified  | Local                          | 21.7*               | Median                           | Referral-to-death            | Good (30)                       |
| Dunn, 2018 [157]            | USA         | Very high | 4b                                | RO          | 96             | 0%                                      | 76² 3%       | U                | Mixed                | Combined     | Local                          | 24*                 | Mean                             | Referral-to-death            | Fair (22)                       |
| Gainza-Miranda, 2018 [158]  | Spain       | Very high | 4a                                | PO          | 60             | 30%                                     | 74² 20%      | U                | Non-malignant          | Community/ home   | Local                          | 252.49*              | Median                           | Survival                      | Good (28)                       |
| Gidwani-Marszowski, 2018 [159] | USA      | Very high | 4b                                | RO          | 1,467, 835    | 0%                                      | U 0%         | 90%              | Non-malignant          | Combined     | National                       | 14.17*               | Median                           | Referral-to-death            | Good (30)                       |
| Gill, 2018 [160]             | USA         | Very high | 4b                                | PO          | 244            | 0%                                      | 87² 65%      | 89%              | Mixed                | Combined     | Regional                       | 12.5*, 40.2*         | Median                           | Referral-to-death            | Good (29)                       |
| Gusu, 2018 [161]            | Canada      | Very high | 4b                                | RO          | 316            | 0.03%                                    | 85² 5.2%     | U                | Mixed                | SPCU          | Local                          | 256.2*              | Mean                             | Length-of-stay                | Fair (25)                       |
| Hattori, 2018 [162]          | Japan       | Very high | 4b                                | PO          | 1924           | 0%                                      | 68² 43%      | U                | Malignant              | SPCU          | Local                          | 38.5*               | Mean                             | Length-of-stay                | Fair (26)                       |
| Hausner, 2018 [163]          | Canada      | Very high | 4b                                | RO          | 156            | 0%                                      | 66² 4.7%     | U                | Malignant              | SPCU          | Local                          | 8*                  | Median                           | Length-of-stay                | Fair (25)                       |
| Hung, 2018 [164]             | Taiwan      | Very high | 4a                                | RO          | 97,614         | 0%                                      | U 38%        | U                | Malignant              | Combined     | National                       | 28*, 62.12*          | Median                           | Referral-to-death            | Fair (26)                       |
| Hutchinson, 2018 [165]       | USA         | Very high | 4b                                | RO          | 5,298          | 0%                                      | U 32%        | 98%              | Malignant              | Combined     | National                       | 17*                 | Median                           | Referral-to-death            | Good (29)                       |
| Johnson, 2018 [166]          | USA         | Very high | 4b                                | RO          | 101            | 28%                                     | 57² 5.3%     | U                | Non-malignant          | Combined     | National                       | 42*                 | Median                           | Referral-to-death            | Fair (26)                       |
| Kaufman, 2018 [167]          | USA         | Very high | 4b                                | RO          | 43,737         | U                                        | U 56%        | U                | Mixed                | Combined     | National                       | 26*, 70*             | Median                           | Referral-to-death            | Fair (24)                       |
| LeBlanc, 2018 [168]          | USA         | Very high | 4b                                | RO          | 9,230          | 0%                                      | 79² 4.4%     | 87%              | Malignant              | Combined     | National                       | 9*                  | Median                           | Referral-to-death            | Fair (27)                       |
| Ledoux, 2018 [169]           | France      | Very high | 4b                                | RO          | 1              | 0%                                      | 69² 3.8%     | U                | Malignant              | General hospital ward | Local                          | 1*, 1*                  | Median                           | Referral-to-death            | Fair (27)                       |
| Lo, 2018 [170]               | Canada      | Very high | 4b                                | RO          | 780            | 4%                                       | 80² 5.2%     | U                | Mixed                | SPCU          | Local                          | 324.1*               | Mean                             | Length-of-stay                | Fair (27)                       |
| McDermott, 2018 [171]        | USA         | Very high | 4b                                | RO          | 835            | 0.6%                                     | 7² 4.9%      | 86%              | Malignant              | Combined     | National                       | 14*                 | Median                           | Referral-to-death            | Fair (27)                       |
| Mendieta, 2018 [172]         | USA         | Very high | 4b                                | RO          | 54,105         | 0%                                       | 83² 49%      | 71%              | Mixed                | Combined     | National                       | 7.05*                | Mean                             | Referral-to-death            | Fair (23)                       |
| Study author and citation | Country | UNDP HDI | WHPCA palliative care development | Study design | No. of patients | % patients alive at end of study period | Age | Gender (% female) | Ethnicity (% White Caucasian) | Type of disease | Type of palliative care service | Level of analysis | Duration of palliative care (days) | Statistical summary reported | Terminology used to report duration of palliative care | Hawker’s criteria rating (score) |
|---------------------------|---------|----------|-----------------------------------|--------------|----------------|----------------------------------------|-----|------------------|------------------------------|----------------|-----------------------------|----------------|--------------------------------|--------------------------|--------------------------------|-------------------------------|
| Merchant, 2018 [173]      | Canada  | Very high| 4b RO                             | 25,446       | 0%             | 71+ 40% U                              | Malignant | Combined         | Regional                    | 76+            | Median                      | Referral-to-death         | Poor (17)                     |                              |
| Mulville, 2018 [174]      | USA     | Very high| 4b RO                             | 161          | 0%             | 74+ 46% U                              | Malignant | Combined         | Local                       | 10*, 38+       | Median and mean             | Referral-to-death         | Poor (17)                     |                              |
| Nazim, 2018 [175]         | Canada  | Very high| 4b RO                             | 28           | 0%             | 80+ 39% U                              | Non-malignant | General hospital ward | Local                       | 6+            | Median                      | Referral-to-death         | Fair (26)                     |                              |
| O’Hare, 2018 [176]        | USA     | Very high| 4b RO                             | 133,062      | 4%             | 70+ 47% U                              | Non-malignant | Combined         | National                    | 6+, 23.48+     | Median and mean             | Referral-to-death         | Fair (24)                     |                              |
| Rozman, 2018 [177]        | Brazil  | High     | 3a RO                             | 2,985        | 0%             | 64+ 45% U                              | Malignant | Combined         | Local                       | 34+, 72.3+     | Median and mean             | Referral-to-death         | Fair (26)                     |                              |
| Shih, 2018 [178]          | Taiwan  | Very high| 4a RO                             | 3931         | 0%             | 72+ 35% U                              | Mixed     | Combined         | Local                       | 1269+         | Median                      | Referral-to-death         | Fair (26)                     |                              |
| Shinall Jr, 2018 [179]    | USA     | Very high| 4b RO                             | 3,321        | 50%            | 68+ 48% U                              | Mixed     | SPCU             | Local                       | 3+            | Median                      | Referral-to-death         | Length-of-stay               | Fair (27)                     |
| Stephens, 2018 [180]      | USA     | Very high| 4b RO                             | 299          | 0%             | 56+ 51% U                              | Mixed     | General hospital ward | Local                       | 3+            | Median                      | Referral-to-death         | Good (28)                    |                              |
| Vogl, 2018 [181]          | Germany | Very high| 4b RO                             | 784          | 42%            | 71+ 55% U                              | Mixed     | SPCU             | Local                       | 9,8+          | Mean                        | Length-of-stay             | Fair (27)                     |                              |
| Wadhwa, 2018 [182]        | Canada  | Very high| 4b RO                             | 337          | 0%             | 65+ 48% U                              | Malignant | Community/ home  | Local                       | 103.41*, 206.83+ | Median and mean             | Referral-to-death         | Good (28)                     |                              |
| Yennurajalingam, 2018 [183]| USA     | Very high| 4b RO                             | 340          | 0%             | 62+ 47% U                              | Malignant | Community/ home  | Local                       | 152.08+        | Median                      | Referral-to-death         | Fair (27)                     |                              |
| Yoo, 2018 [184]           | South Korea | Very high| 3a RO                             | 277          | 0%             | 62+ 39% U                              | Malignant | Combined         | Local                       | 45.2+         | Mean                        | Referral-to-death         | Good (31)                    |                              |
| Ziegler, 2018 [185]       | UK      | Very high| 4b RO                             | 1,598        | 0%             | 49+ U                                  | Malignant | Combined         | Local                       | 42+           | Mean                        | Referral-to-death         | Good (29)                    |                              |
| Chai (personal communication, Coyte PC, University of Toronto)       | Canada  | Very high| 4b RO                             | 81           | 0%             | U U U                                  | Malignant | Community/ home  | Local                       | 65+, 111.56+    | Median and mean             | Referral-to-death         | U                           |                              |

UNDP HDI United Nations Development Programme Human Development Index, WHPCA Worldwide Hospice Palliative Care Alliance, RO retrospective observational, U unspecified (data neither available nor possible to calculate), SPCU specialist palliative care unit, USA United States of America, UK United Kingdom, PI prospective interventional, PO prospective observational

*Median
†Weighted due to multiple subgroups with individual summaries of duration of palliative care
‡Mean
§Value for larger cohort of study participants including those not referred to palliative care
care services (31% SPCU, 11% community/home and 7% hospital), with studies reporting in combined settings (50%) accounting for 95% of all participants.

Of all included articles, 46 (27%) were length-of-stay studies. The proportion of patients alive at the end of each study is outlined in Table 1. In 28 of the length-of-stay studies (60.9%) fewer than 10% of patients were alive, with 22 (47.8%) having no patients alive at the end of study.

Study quality was rated as good in 73 (43%) studies, fair in 90 (53%) and poor in 5 (3%). Studies rated as good accounted for 64% of total participants although studies variably summarised the duration of palliative care with inconsistent measures of spread. A table of individual study quality appraisals can be found in Additional file 2: Table S3.

The weighted median duration of palliative care until death was 18.9 days (IQR 0.09, Table 2). Three studies had more than one million participants each [48, 113, 159]. The median duration of palliative care excluding these studies (total 16.7% participants) was 19.2 days (IQR 15). The weighted median duration in days until death per country, by service type, disease type, WHPCA level of palliative care development, and UNDP Human Development Index is reported in Table 2.

Analyses of the influence of study characteristics on the overall weighted median duration of palliative care until death are outlined in Additional file 2: Table S4. Studies rated as poor and fair did not significantly adjust the duration of palliative care for the whole dataset, but they significantly reduced the duration of palliative care when looking at non-USA studies alone. Studies tended to report longer mean than median durations where both were used, reflecting positively skewed data. Studies in which mean durations were converted to medians did not affect the outcome for the whole dataset, but did significantly increase the duration of palliative care for non-USA studies. Even excluding studies with more than one million participants did not greatly alter the duration of palliative care (i.e. 19.2 days).

The spread of median duration of palliative care values according to sample size is demonstrated in Figs. 2 and 3.

Figure 2 outlines the difference in median days duration of palliative care prior to death according to country level of human development and palliative care development. Studies from countries with a very high level of human development had a shorter duration of palliative care than less developed countries (18.9 vs. 34.0 days, \( p < 0.001 \)). Similarly, as shown in Fig. 3, studies from countries with the greatest level of palliative care development had a shorter duration of palliative care than countries with lower levels (18.9 vs. 28.0 days, \( p < 0.001 \)). Not all studies reported duration of palliative care for patients with both malignant and non-malignant disease, and across a combination of palliative care settings. Consequently, we conducted sub-analyses using data on the type of disease available in 105 of the included studies (i.e. 62.1%) and the type of palliative care setting using data from 82 studies (i.e. 48.5%). The median duration of palliative care was nine days longer for studies reporting on patients with malignant disease compared with non-malignant disease (15.0 vs. 6.0, \( p < 0.001 \)). Studies conducted in specialist palliative care units and community/home settings reported a similar duration of palliative care, both longer than in general hospital ward settings (19.2 vs. 20.0 vs. 6.0 days, respectively, \( p < 0.001 \)). A further sub-analysis, comparing data from the USA and non-USA countries, was performed given the preponderance of data from the former. The median duration of palliative care in studies from the USA was ten fewer days than in non-USA studies (18.9 vs. 29.0, \( p < 0.001 \)).

The median duration of palliative care was unaffected by studies reporting local or regional data, reporting duration of palliative care as a mean solely, reporting length-of-stay, studies with < 100 participants and studies rated as fair or poor quality. It was, however, reduced to 14.71 days (IQR 0.83; MAD 8.23) after excluding studies with > 5% patients alive at the end of the study period. Sensitivity analysis showed that studies rated as poor and fair did not significantly adjust the duration of palliative care for the whole dataset, but they significantly reduced the duration of palliative care when looking at non-USA studies alone.

Given differences between studies from and outside of the USA, we hypothesised that non-USA studies may have different factors influencing the duration of palliative care. We conducted additional analyses excluding USA data (Additional file 2: Tables S4 and S5). Studies from non-USA countries with a very high level of human development still had a shorter duration of palliative care than less developed countries (29.0 vs. 34.0 days, \( p < 0.001 \)). However, studies from non-USA countries with the greatest level of palliative care development had a longer duration of palliative care than countries with lower levels of palliative care development (68.9 vs. 28.0 days, \( p < 0.001 \)). Studies involving patients with malignant disease reported a longer duration of palliative care than those with non-malignant disease; however, the difference was smaller (28.0 vs. 24.3 days, \( p < 0.001 \)). Studies conducted in community or home settings had a longer duration of palliative care than those conducted in specialist palliative care units and general hospital ward settings (47.9 vs. 14.8 vs. 6.0 days, respectively, \( p < 0.001 \)).

The sensitivity analyses showed the median duration of palliative care for non-USA studies was unaffected by length-of-stay, studies with <100 participants, and
| Country  | Service type                   | Weighted median duration of palliative care in days (IQR) | p value |
|---------|--------------------------------|--------------------------------------------------------|---------|
| All studies |                                | 18.91 (0.09)                                         |         |
| Australia | Specialist palliative care     | 14.81 (0.00)                                         |         |
|          | Community/home                 | -                                                      |         |
|          | General hospital ward          | 6.00 (0.00)                                          |         |
|          | Combined                        | 25.00 (0.00)                                         |         |
| Austria  | Specialist palliative care     | 16.00 (5.00)                                         |         |
|          | Community/home                 | -                                                      |         |
|          | General hospital ward          | -                                                      |         |
|          | Combined                        | 9.00 (0.00)                                          |         |
| Belgium  | Specialist palliative care     | -                                                      |         |
|          | Community/home                 | -                                                      |         |
|          | General hospital ward          | -                                                      |         |
|          | Combined                        | 17.95 (0.00)                                         |         |
| Brazil   | Specialist palliative care     | -                                                      |         |
|          | Community/home                 | 115.02 (0.00)                                        |         |
|          | General hospital ward          | -                                                      |         |
|          | Combined                        | 34.00 (0)                                            |         |
| Canada   | Specialist palliative care     | 25.60 (3.73)                                         |         |
|          | Community/home                 | 47.92 (0.00)                                         |         |
|          | General hospital ward          | 6.00 (0.00)                                          |         |
|          | Combined                        | 68.88 (0.00)                                         |         |
| China    | Specialist palliative care     | 19.00 (0.00)                                         |         |
|          | Community/home                 | -                                                      |         |
|          | General hospital ward          | -                                                      |         |
|          | Combined                        | -                                                      |         |
| Denmark  | Specialist palliative care     | -                                                      |         |
|          | Community/home                 | -                                                      |         |
|          | General hospital ward          | -                                                      |         |
|          | Combined                        | -                                                      |         |
| Egypt    | Specialist palliative care     | 66.00 (0.00)                                         |         |
|          | Community/home                 | -                                                      |         |
|          | General hospital ward          | -                                                      |         |
|          | Combined                        | -                                                      |         |
| Finland  |                                | 25.37 (0.00)                                         |         |
Table 2 Duration of palliative care in days prior to death, by country and other characteristics (Continued)

| Country         | Weighted median duration of palliative care in days (IQR) | p value |
|-----------------|-----------------------------------------------------------|---------|
| France          | Specialist palliative care: 25.37 (0.00)                 |         |
|                 | Community/home: -                                          |         |
|                 | General hospital ward: -                                   |         |
|                 | Combined: -                                                |         |
|                 | 22.00 (0.00)                                               |         |
| Germany         | Specialist palliative care: 13.16 (0.00)                  |         |
|                 | Community/home: -                                          |         |
|                 | General hospital ward: -                                   |         |
|                 | Combined: -                                                |         |
|                 | 13.16 (0)                                                  |         |
| Ireland         | Specialist palliative care: 46.27 (0.00)                  |         |
|                 | Community/home: -                                          |         |
|                 | General hospital ward: 10.30 (0.00)                        |         |
|                 | Combined: 46.27 (0.00)                                     |         |
| Italy           | Specialist palliative care: 21.00 (10.00)                 |         |
|                 | Community/home: -                                          |         |
|                 | General hospital ward: -                                   |         |
|                 | Combined: 21.00 (0.00)                                     |         |
| Japan           | Specialist palliative care: 28.95 (0.00)                  |         |
|                 | Community/home: 35.00 (0.00)                               |         |
|                 | General hospital ward: -                                   |         |
|                 | Combined: 28.00 (0.00)                                     |         |
| Netherlands     | Specialist palliative care: 36.00 (37)                    |         |
|                 | Community/home: -                                          |         |
|                 | General hospital ward: -                                   |         |
|                 | Combined: -                                                |         |
| Saudi Arabia    | Specialist palliative care: 16.63 (*1)                    |         |
|                 | Community/home: -                                          |         |
|                 | General hospital ward: -                                   |         |
|                 | Combined: 16.63 (0.00)                                     |         |
| Singapore       | Specialist palliative care: 8.00 (19)                     |         |
|                 | Community/home: -                                          |         |
|                 | General hospital ward: -                                   |         |
|                 | Combined: 8.00 (0.00)                                      |         |
Table 2 Duration of palliative care in days prior to death, by country and other characteristics (Continued)

| Location                  | Weighted median duration of palliative care in days (IQR) | p value |
|----------------------------|----------------------------------------------------------|---------|
| South Korea                | 22.18 (0.00)                                             |         |
| Specialist palliative care | 22.18 (0.00)                                             |         |
| Community/home             | -                                                        |         |
| General hospital ward      | -                                                        |         |
| Combined                   | 32.63 (0.00)                                             |         |
| Spain                      | 43.52 (0.00)                                             |         |
| Specialist palliative care | -                                                        |         |
| Community/home             | -                                                        |         |
| General hospital ward      | 43.52 (0.00)                                             |         |
| Combined                   | -                                                        |         |
| Taiwan                     | 28.00 (0.00)                                             |         |
| Specialist palliative care | 13.50 (0.00)                                             |         |
| Community/home             | -                                                        |         |
| General hospital ward      | 33.71 (0.00)                                             |         |
| Combined                   | 28.00 (0.00)                                             |         |
| Thailand                   | 33.00 (*†)                                               |         |
| Specialist palliative care | -                                                        |         |
| Community/home             | -                                                        |         |
| General hospital ward      | -                                                        |         |
| Combined                   | 33.00 (0.00)                                             |         |
| Turkey                     | 24.88 (12.35)                                            |         |
| Specialist palliative care | 24.88 (12.35)                                            |         |
| Community/home             | -                                                        |         |
| General hospital ward      | -                                                        |         |
| Combined                   | 33.00 (0.00)                                             |         |
| UK                         | 48.00 (0.00)                                             |         |
| Specialist palliative care | 9.00 (2.40)                                              |         |
| Community/home             | 41.41 (294.59)                                           |         |
| General hospital ward      | -                                                        |         |
| Combined                   | 48.00 (0.00)                                             |         |
| Multicentre – USA & Brazil | 6.00 (5†)                                                |         |
| Specialist palliative care | 6.00 (0.00)                                              |         |
| Community/home             | -                                                        |         |
| General hospital ward      | -                                                        |         |
| Combined                   | 6.00 (0.00)                                              |         |
| USA                        | 18.91 (0.09)                                             |         |
| Specialist palliative care | 19.20 (17.72)                                            |         |
| Community/home             | 20.00 (0.00)                                             |         |
| General hospital ward      | 3.00 (12.01)                                             |         |
| Combined                   | 18.91 (0.09)                                             |         |
| USA vs non-USA studies     | USA                                                      | p < 0.001|
|                           | 18.91 (0.09)                                             |         |
|                           | All non-USA studies                                     | 29.00 (40.88) |
| UNDP Human Development Index (2015) | Very high           | 18.91 (0.09) |
|                           | High                                                     | 34.00 (0)  |
studies with > 5% of cohorts alive at the end of the study periods. However, it was reduced to 28.0 days after excluding local and regional studies (IQR 1.00; MAD 8.00) and studies reporting duration of palliative care as a mean solely (IQR 20.00; MAD 14.00) and was increased to 48.0 days (IQR 39.88; MAD 25.41) after excluding poor/fair quality studies.

**Discussion**

In this systematic review, 169 studies were included, involving 11,996,479 patients. 43% of studies were of good quality and studies variably summarised duration of palliative care with inconsistent measures of spread. Internationally, half of all patients accessing palliative care services are referred less than 19 days before death, although we found very large diversity in the median duration of palliative care in days prior to death across the countries in this review, from 6 days in Australia to 69 days in Canada. The median number of days of palliative care prior to death for all US studies was 19 days, and for all non-US studies, it was 29 days. Cancer patients have a longer duration of palliative care as compared with those with non-malignant disease. We found palliative care duration is comparable for patients referred to specialist inpatient units and community settings, but significantly longer than for patients in a general hospital ward. At a country level, human development index level and the extent of palliative care development had an unexpected negative effect on the duration of palliative care.

This large systematic review and meta-analysis of international data found the duration of palliative care before death for patients with life-limiting illness is much shorter (i.e. a median of 19 days) than is supported by research evidence and widely advocated in health care policy. Davis et al.’s systematic review of randomised trials of early integration of outpatient and home palliative care concluded that care must be provided for at least 3–4 months before death to reach maximal benefit [5]. Although we appreciate duration and content of palliative care should be guided by individual patient needs without a one-size-fits-all approach, we are concerned that this reflects a gap between the current practice of palliative care in the terminal phase of life and the timely initiation of palliative care, which impacts on the benefit of palliative care for patients and health care services. This work extends previous efforts by the team to

| Table 2 Duration of palliative care in days prior to death, by country and other characteristics (Continued) |
| --- |
| Weighted median duration of palliative care in days (IQR) | p value |
| Medium 66.00 (*†) |  |
| No data 6.00 (5) |  |
| Very high 18.91 (0.09) | p < 0.001 |
| < Very high 34.00 (1.00) |  |
| WHPCA categorisation of palliative care development (2011) |
| 4b 18.91 (0.09) |  |
| 4a 28.00 (0) |  |
| 3b 24.88 (12.35) |  |
| 3a 22.18 (11.82) |  |
| No data 6.00 (5) |  |
| 4b 18.91 (0.09) | p < 0.001 |
| < 4b 28.00 (0) |  |
| Type of disease |
| Malignant 15.00 (7.18) | p < 0.001 |
| Non-malignant 6.00 (1.00) |  |
| Mixed 18.91 (0.09) |  |
| Unspecified 14.81 (0) |  |
| Type of palliative care service |
| Specialist palliative care unit 19.20 (17.72) | p < 0.001 |
| Community/home 20.00 (0) |  |
| General hospital ward 6.00 (0) |  |
| Combined 18.91 (0.09) |  |
| Unspecified 21.70 (167.40) |  |

Median data weighted against the size of the study population of included studies

IQR interquartile range, UK United Kingdom, USA United States of America

*Data neither available nor possible to calculate

†IQR from single study sample
understand the duration of hospice-based specialist palliative care in the UK [8]. This review augments the focus to include data across multiple care settings, including hospital, home and the community, alongside novel comparisons of the duration of palliative care across countries internationally.

Variation in the duration of palliative care before death across countries reflected a range from a median of 6 days (Australia) to 69 days (Canada). Whilst this reflects only published data there is stark variation, with duration of palliative care encompassing only a few days prior to death for some countries. Data from countries may, to some extent, reflect the country-specific provision of palliative care. For example, data from the USA reflected patients receiving ten fewer days in palliative care than those in non-USA countries. This may be explained by USA models of care that restrict hospice care to patients with prognoses less than six months and require patients to stop active treatments that may still be beneficial [186]. Given high levels of palliative care development and human development of included non-USA studies, it is likely that these countries are able to offer similar life-prolonging and supportive healthcare interventions as the USA [187].

Longer duration of palliative care for patients with malignant disease compared with those with non-malignant
disease, as found in this study, is consistent with a UK report that found patients with cancer were predominantly referred to palliative care services despite only accounting for 29% of deaths in 2012–2013 [188]. Allsop et al. found cancer patients had a significantly longer median duration between referral to UK hospices and death compared with non-cancer patients (53 days vs. 27 days, $p < 0.0001$) [8]. This occurs despite evidence that palliative care needs and symptom burden are comparable between cancer and non-cancer groups [189, 190]. Although evidence in support of palliative care interventions is predominantly from studies involving patients with cancer, this is emerging for non-cancer groups [4]. Siouta et al. found that guidelines and pathways supporting the integration of palliative care in major non-malignant disease are increasingly involving earlier palliative care integration but lack information on referral criteria [191]. Other barriers to accessing palliative care in this group must be understood in order to improve integration of care.

We found palliative care duration is comparable for patients referred to specialist inpatient units and community settings, but that this was significantly longer than for patients referred as general hospital inpatients. This is consistent with studies comparing the duration of palliative care between outpatient or home palliative care and general hospital settings, and probably reflects greater referrals of patients in the last days of life in the latter setting [10, 55, 64]. Hui et al. found that patients referred to outpatient palliative care had improved end of life care more than those who received inpatient palliative care from mobile teams [55]. It may be appropriate to concentrate efforts to increase the duration of palliative care in outpatient settings, prior to a longer-term goal of increasing duration of palliative care in all settings. Non-USA patients already spend fewer days in specialist palliative care units and more days in community palliative care, which may reflect patient preference, or reduced capacity of and access to inpatient settings [192].

We found a negative correlation between duration of palliative care and country level of human development. For the limited studies that were not categorised as ‘very high’ according to the United Nations Human Development Index, all but one reported data on malignant conditions. The negative correlation may, therefore, partly reflect the longer duration of palliative care for patients with malignant disease found across all studies. However, the extent to which firm conclusions can be drawn regarding the duration of palliative care and country level of human development is limited. Firstly, the predominance of malignant disease does not reflect the current multitude of diseases and symptoms that characterise health conditions requiring palliative care in the context of low and middle-income countries [6]. Secondly, no studies were included from countries classified as ‘low’ using the United Nations Human Development Index. This review highlights the wider need to support increases in research capacity in the context of low and middle-income countries (LMICs) to better understand the provision of palliative care [6]. There remains a disparity of the reporting of palliative care research in LMICs which needs to be prioritised [193]. These are the countries in which the greatest proportional rise in serious health-related suffering is projected to occur [7]. Alongside efforts to, for example, utilise routinely collected datasets to determine the temporal nature of initiating and subsequent duration of palliative care in LMICs [194], efforts to better understand optimal timing and provision of palliative care in these settings is required. It is not appropriate to extrapolate the existing evidence for early referrals, largely from high-income settings, to countries and settings in which palliative care is critically absent and largely a poverty-reduction intervention to lessen significant costs that can be absorbed by the individual, family and local community arising from incurable illnesses [195].

The main strength of this systematic review is the inclusion of a large number of studies with over 11 million participants, giving significant power to our findings. Duration of palliative care was difficult to define due to the range of different palliative care settings and terminology used to describe this outcome measure. We used a complex search strategy including supplementary searching to identify studies that used inconsistent terminology for palliative care and duration of palliative care. It was not possible to use a statistical method to assess heterogeneity or publication bias. However, we conducted sensitivity analyses in order to further interrogate the data and explain any heterogeneity within the data. Limitations included the definition of palliative care services and the use of length-of-stay in our inclusion criteria. Individual studies were unclear on the level of training and experience of palliative care practitioners and services. Therefore, we chose to assume that services self-defining as specialist palliative care were such but may have included some studies from services with less specialist experience. We used length-of-stay in an inpatient specialist palliative care setting as a proxy for the duration of palliative care as many patients are first referred to these settings and die during first admissions. Across half of all length-of-stay studies included in this review, the entire study population had died at the end of the study period. However, we acknowledge that it is increasingly common for patients to have short inpatient admissions for symptom control with eventual discharge. In the UK, 32% of patients admitted to inpatient hospices are discharged [196]. As such this may not fully reflect the breadth of input from palliative care services and patients.
admitted to inpatient hospices may have had earlier contact with community or hospital palliative care services. Consequently, the use of length-of-stay could underestimate the duration of palliative care. However, our sensitivity analyses showed that studies reporting length-of-stay did not significantly alter the overall duration of palliative care. Studies reporting >5% survival at the end of the study period significantly increased the duration of palliative care for the whole dataset, suggesting that our main finding may be an overestimation.

Conclusions
This review suggests that duration of palliative care before death for patients with life-limiting illness is much shorter than is supported by research evidence and widely advocated in health care policy. Our study also highlights wide variation at the level of country, across disease types and settings to which patients are referred. This review draws attention to the increasing extent to which palliative care research is capturing the duration and interaction provided to patients and their families. However, to better understand the timing of palliative care provision internationally, we welcome more consistent terminology and methodology, and routine assessment of duration of palliative care from all countries, to allow benchmarking, service evaluation and quality improvement. This could lead to a greater understanding of the duration of palliative care and associated factors. However, we acknowledge that further research is required across all countries to understand the mechanisms influencing differences in the duration of palliative care received, across the levels of patients, caregivers, health professionals, policymakers and the public, and the settings in which care is provided. In particular, there is a need for greater reporting in less developed settings where there is a dearth of related literature and likely to be the greatest need in future [7]. Reducing barriers to accessing palliative care and promoting earlier integration alongside active treatment would maximise benefits to patients before they die and reduce costs to the wider healthcare service.

Supplementary Information
Supplementary information accompanies this paper at https://doi.org/10.1186/s12916-020-01829-x.

Additional file 1: Fig S1. Example of search strategy as used in MEDLINE, PNE. Fig S2. Linear regression model used to compare mean and median values.

Additional file 2: Table S1. PRISMA checklist. Table S2. Summary of characteristics of studies. Table S3. Individual study quality appraisal using Hawker’s criteria. Table S4. Summary of characteristics of studies (excluding USA data). Table S5. Duration of care with sub-analyses (excluding USA data).

Abbreviations
IQR: Interquartile range; LMICs: Low- and middle-income countries; MAD: Median absolute deviation; RCTs: Randomised controlled trials; UK: United Kingdom; USA: United States of America

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Authors’ contributions
MIB conceived the idea for the paper. RIJ and MJA designed the search strategy and conducted the literature searches. RIJ, MJA, YE, CEJ, HLE and EJC were involved in study selection, data extraction and quality assessment. RIJ and MJA undertook data analysis. RIJ, MJA, CEJ and MIB drafted the manuscript. All authors edited and agreed the final manuscript.

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Competing interests
The authors declare that they have no competing interests.

Author details
1 Academic Unit of Palliative Care, Leeds Institute of Health Sciences, University of Leeds, Leeds, UK. 2 Wolfson Palliative Care Research Centre, Hull York Medical School, University of Hull, Hull, UK. 3 End-of-Life Care Research Group, Ghent University, Ghent, Belgium. 4 Vrije Universiteit Brussel, Brussels, Belgium.

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References
1. World Health Organisation. Cancer: WHO Definition of Palliative Care, 2019. https://www.who.int/cancer/palliative/definition/en/. Accessed 29 Apr 2019.
2. Gaertner J, Siemens W, Meerpohl JJ, et al. Effect of specialist palliative care services on quality of life in adults with advanced incurable illness in hospital, hospice, or community settings: systematic review and meta-analysis. BMJ. 2017;357:j2925.
3. Kavalieratos D, Corbelli J, Zhang D, et al. Association between palliative care and patient and caregiver outcomes: a systematic review and meta-analysis. JAMA. 2016;316(20):2104–14.
4. Gomes B, Calanzani N, Cutale V, et al. Effectiveness and cost-effectiveness of home palliative care services for adults with advanced illness and their caregivers. Cochrane Database of Systematic Reviews 2013; Art. No.: CD007760. https://doi.org/10.1002/14651858.CD007760.pub2.
5. Davis MP, Terrell JS, Balboni T, et al. A review of the trials which examine early integration of outpatient and home palliative care for patients with serious illnesses. Ann Palliat Med. 2015;4(3):99–121.
6. Knaul FM, Farmer PE, Krakauer EL, et al. Alleviating the access abyss in palliative care and pain relief—an imperative of universal health coverage: the Lancet Commission report. Lancet. 2018;391(10128):1391–454.
7. Steenman KE, de Brito M, Ekild S, et al. The escalating global burden of serious health-related suffering: projections to 2060 by world regions, age groups, and health conditions. Lancet Glob Health. 2019;7(7):e883–92.
8. Alltop MJ, Ziegler LE, Mulvey MR, et al. Duration and determinants of hospice-based specialist palliative care: a national retrospective cohort study. Palliat Med. 2018;32(8):1322–33.
60. Obermeyer Z, Makor M, Abujaber S, et al. Association between the medicare hospice benefit and health care utilization and costs for patients with poor-prognosis cancer. JAMA. 2014;312(18):1888–96.

61. Olmsted CL, Johnson AM, Kaboli P, et al. Use of palliative care and hospice among surgical and medical specialties in the veterans health administration. JAMA Surg. 2014;149(11):1169–75.

62. Scheffey C, Kestenbaum MG, Wachterman MW, et al. Clinic-based outpatient palliative care before hospice is associated with longer hospice length of service. J Pain Symptom Manage. 2014;48(4):532–9.

63. Seow H, Brazel K, Sussman J, et al. Impact of community based, specialist palliative care teams on hospitalisations and emergency department visits late in life and hospital deaths: a pooled analysis. BMJ. 2014;348:g3496.

64. Sexauer A, Cheng MJ, Knight L, et al. Patterns of hospice use in patients dying from hematoPOietIC malignancies. J Palliat Med. 2014;17(2):195–9.

65. Shin SH, Hui D, Chisholm GB, et al. Characteristics and outcomes of patients admitted to the acute palliative care unit from the emergency center. J Pain Symptom Manage. 2014;47(6):1028–34.

66. Unnoe KT, Sachs GA, Dennis ME, et al. Hospice use among nursing home and non-nursing home patients. J Gen Intern Med. 2015;30(2):193–8.

67. Wachterman MW, Lipsitz SR, Simon SR, et al. Patterns of hospice care among military veterans and non-veterans. J Pain Symptom Manage. 2014;48(1):36–44.

68. Yamashigi A, Morita T, Kawagoe S, et al. Length of hospice home care, family-perceived timing of referrals, perceived quality of care, and quality of death and dying in terminally ill cancer patients who died at home. Support Care Cancer. 2014;22(2):491–9.

69. Yeung HN, Mitchell WM, Roeland EJ, et al. Palliative radiation before hospice: the long and the short of it. J Palliat Med. 2014;48(6):1070–9.

70. Alisrafi SA, Abou-Alia AM, Gharem HM. Palliative care consultation versus palliative care unit: which is associated with shorter terminal hospitalization length of stay among patients with cancer? Am J Hosp Palliat Care. 2015;32(3):275–9.

71. Chiang J-K, Kao Y-H, Lai N-S. The impact of hospice care on survival and quality indicators of end-of-life care service and survival in terminal cancer patients. Support Care Cancer. 2015;23(4):1057–62.

72. Myers J, Kim A, Flanagan J, et al. Palliative performance scale and survival among outpatients with advanced cancer. Support Care Cancer. 2015;23(4):913–18.

73. O’Connor TL, Nygampahilboon N, Gorran A, et al. Hospice utilization and end-of-life care in metastatic breast cancer patients at a comprehensive cancer center. J Palliat Med. 2015;18(1):50–5.

74. Pineau ER. Palliative care for the homeless: an intervention to reduce the healthcare economic cost. WURJ. 2015;5(1):Article 2. https://doi.org/10.5206/wurjns.2014-15.2.

75. Zakhour M, Labrani L, Rimel BJ, et al. Too much, too late: Aggressive measures and the timing of end of life care discussions in women with gynecologic malignancies. Gynecol Oncol. 2015;138(2):383–7.

76. Bauman JR, Piotrowska Z, Muzikansky A, et al. End-of-life care in patients with metastatic lung cancer harboring epidermal growth factor receptor mutations. J Palliat Med. 2016;19(12):1316–9.

77. Brooks GA, Cronin AM, Uro H, et al. Intensity of medical interventions between diagnosis and death in patients with advanced lung and colorectal cancer: A CanCORS analysis. J Palliat Med. 2016;19(1):142–50.

78. Brown CL, Hamlill BG, Qualls LG, et al. Significant morbidity and mortality among hospitalized end-stage liver disease patients in medicare. J Pain Symptom Manage. 2016;52(3):412–9.

79. Cheraghli S, Ghabauer EA, Leo-Summers L, et al. Restricting symptoms before and after admission to hospice. Am J Med. 2016;129(7):754–757, e155.

80. Diamond EL, Russell D, Kryza-Lacombe M, et al. Rates and risks for late referral to hospice in patients with primary malignant brain tumors. Neuro Oncol. 2016;18(1):78–86.

81. Hamano J, Yamaguchi T, Maeda I, et al. Multicenter cohort study on the survival time of cancer patients dying at home or in a hospital: Does place matter? Cancer. 2016;122(9):1453–60.

82. Jarosek SL, Shippee TP, Vinig MA. Place of death of individuals with terminal cancer: new insights from medicare hospice place-of-service codes. J Am Geriatr Soc. 2016;64(9):1815–22.

83. Jegier BJ, O'Mahony S, Johnson J, et al. Impact of a centralized inpatient hospice unit in an academic medical center. J Hosp Palliat Care. 2016;33(8):755–9.

84. Kiser EL, Parker KA, Weiker D, Masel DK, et al. Polypharmacy in the terminal stage of cancer. Support Care Cancer. 2016;24(5):2067–74.

85. King JD, Eckhoff J, Traynor A, et al. Integrated onco-palliative care associated with prolonged survival compared to standard care for patients with advanced lung cancer: a retrospective review. J Pain Symptom Manage. 2016;51(6):1027–32.

86. Lowe SS, Nekolahchuk C, Ghosh S, et al. Clinical characteristics of patients having single versus multiple patient encounters within a palliative care programme. BMJ Support Palliat Care. 2016; published online Feb 04. https://doi.org/10.1136/bmjpsychcare-2015-000985.

87. Masman AD, van Dijk M, van Rosmalen J, et al. Bispectral index monitoring in terminally ill patients: a validation study. J Pain Symptom Manage. 2016;52(2):212–20.

88. Obermeyer Z, Clarke AC, Makar M, et al. Emergency care use and the Medicare hospice benefit for individuals with cancer with a poor prognosis. J Am Geriatr Soc. 2016;64(2):323–9.

89. Odeje OD, Cronin AM, Earle CC, et al. Hospice utilization among patients with lymphoma: impact of disease aggressiveness and curability. J Natl Cancer Inst. 2016;108(1): published online Jan 01. https://doi.org/10.1093/jnci/djv080.

90. Peer GA, Bunn S, Oh YJ, et al. Attributes and outcomes of end stage liver disease as compared with other noncancer patients admitted to a geriatric palliative care unit. Ann Palliat Med. 2016;5(2):76–82.

91. Porteous A, Dewhurst F, Gray WK, et al. Screening for delirium in specialist palliative care inpatients: perceptions and outcomes. Int J Palliat Nurs. 2016;22(9):444–7.
107. Rosenwax L, Spilsbury K, McNamara BA, et al. A retrospective population based cohort study of access to specialist palliative care in the last year of life: who is still missing out a decade on? BMC Palliative Care. 2016;15(1):46.

108. Sathornviriyapong A, Nagavijj K, Anothaisintawee T. The association between different opioid doses and the survival of advanced cancer patients receiving palliative care. BMC Palliative Care. 2016;15(1):95.

109. Schmalz O, Strapsatatis A, Alefelder C, et al. Methicillin-resistant Staphylococcus aureus in palliative care: a prospective study of Methicillin-resistant Staphylococcus aureus prevalence in a hospital-based palliative care unit. Palliat Med. 2016;30(7):703–6.

110. Schur S, Wexler D, Gabi C, et al. Sedation at the end of life - a nation-wide study in palliative care units in Austria. BMC Palliative Care. 2016;15(1):50.

111. Senderovich H, Ip ML, Berea A, et al. Therapeutic touch (R) in a geriatric palliative care unit - a retrospective review. Complement Ther Clin Pract. 2016;24:134–8.

112. Sharma N, Sharma AM, Wojtowycz MA, et al. Utilization of palliative care and acute care services in older adults with advanced cancer. J Geriatr Oncol. 2016;7(1):39–46.

113. Stevenson DG, Grabowski DC, Keating NL, et al. Hospice utilization in patients with lung cancer: a nationwide multicentre study. Eur J Cancer Care. 2017;15(2):15.

114. Stevenson DG, Grabowski DC, Keating NL, et al. Hospice utilization in patients with lung cancer: a nationwide multicentre study. Eur J Cancer Care. 2017;15(1):15.

115. Stevenson DG, Grabowski DC, Keating NL, et al. Hospice utilization in patients with lung cancer: a nationwide multicentre study. Eur J Cancer Care. 2017;15(1):15.

116. Stevenson DG, Grabowski DC, Keating NL, et al. Hospice utilization in patients with lung cancer: a nationwide multicentre study. Eur J Cancer Care. 2017;15(1):15.

117. Stevenson DG, Grabowski DC, Keating NL, et al. Hospice utilization in patients with lung cancer: a nationwide multicentre study. Eur J Cancer Care. 2017;15(1):15.

118. Stevenson DG, Grabowski DC, Keating NL, et al. Hospice utilization in patients with lung cancer: a nationwide multicentre study. Eur J Cancer Care. 2017;15(1):15.

119. Stevenson DG, Grabowski DC, Keating NL, et al. Hospice utilization in patients with lung cancer: a nationwide multicentre study. Eur J Cancer Care. 2017;15(1):15.

120. Stevenson DG, Grabowski DC, Keating NL, et al. Hospice utilization in patients with lung cancer: a nationwide multicentre study. Eur J Cancer Care. 2017;15(1):15.

121. Stevenson DG, Grabowski DC, Keating NL, et al. Hospice utilization in patients with lung cancer: a nationwide multicentre study. Eur J Cancer Care. 2017;15(1):15.

122. Stevenson DG, Grabowski DC, Keating NL, et al. Hospice utilization in patients with lung cancer: a nationwide multicentre study. Eur J Cancer Care. 2017;15(1):15.

123. Stevenson DG, Grabowski DC, Keating NL, et al. Hospice utilization in patients with lung cancer: a nationwide multicentre study. Eur J Cancer Care. 2017;15(1):15.

124. Stevenson DG, Grabowski DC, Keating NL, et al. Hospice utilization in patients with lung cancer: a nationwide multicentre study. Eur J Cancer Care. 2017;15(1):15.
