

# The role of service factors on variations in place of death: an observational study

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## Scientific summary

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# Scientific summary

## Background

The place of death (PoD) is an important end-of-life care outcome measure that can be objectively observed. Findings from the previous GUIDE\_Care project [Gao W, Ho YK, Verne J, Gordon E, Higginson IJ. Geographical and temporal Understanding In place of Death in England (1984–2010): analysis of trends and associated factors to improve end-of-life Care (GUIDE\_Care) – primary research. *Health Serv Deliv Res* 2014;**2**(42)] revealed that there was a significant geographical variation in the PoD, and sociodemographic and clinical characteristics of individuals explained < 25% of this variation. Service factors, which are a group of mostly modifiable factors, may account for some of the unexplained variance in PoD but their effects had never been evaluated systematically. This study aims to evaluate the role of service factors in PoD, eventually to inform national and local end-of-life care improvement.

## Research questions

1. What is the relative contribution of service factors to geographical variation in PoD?
2. What is the independent effect of service factors on PoD?
3. How do service factors interact with each other and with patient factors to influence the PoD?

## Methods

This study was a national population-based observational study in England. Data were collected at the patient and area level. Patient-level data comprised all non-accidental, adult deaths ( $n = 431,735$ ) in 2014 extracted from the Death Registry Database maintained by the Office for National Statistics (ONS; 29 January 2015). Area-level service data in five categories (commissioning, type and capacity, location, workforce, and service use) were collected from multiple sources in public domains and summarised by the Clinical Commissioning Group (CCG) ( $n = 211$ ) and local authority (LA) ( $n = 152$ ). Patient-level data were linked to the area-level service data through the geographical identifier of the residential address of the deceased. The outcome variable (PoD) at the area level was analysed as the proportion of deaths in hospital, care home, hospice and home. At the individual level, this was analysed as a binary indicator where death that had occurred in a hospital, care home or hospice was 1 and death at home was 0. Data were described by frequency and percentage for categorical variables, and mean (standard deviation) or median (range) for continuous variables as appropriate. Geographical information system (GIS) was used to manage, process and visualise the service profiles.

The relative contribution of individual service categories to area-level variations in PoD was assessed by per cent of variance explained, as measured by the  $R^2$ . The  $R^2$  was derived in two steps: the service variables together with important sociodemographic and clinical variables were used to construct a beta-regression model to predict the proportion of deaths in PoD, and the predicted proportions of PoD were estimated and the correlation coefficient ( $r$ ) with the actual proportions of PoD was calculated. The  $R^2$  was derived by squaring the  $r$ .

The total impact of service factors by individual service categories was evaluated using the area under the receiver operating characteristic curve (AUC), derived by fitting the linked individual- and service-level (multilevel) data to the generalised linear mixed models with the PoD modelled as a binary indicator. The link function was logit and the distribution was binary.

The service variables that created the largest AUC within each individual service category were used to construct multilevel models to evaluate their independent effects on PoD, adjusting for sociodemographic and clinical variables. The effects were measured by the odds ratios (ORs). The interacting effects between service variables, and between service, sociodemographic and clinical variables were also evaluated with the multilevel models. All evaluations were conducted with all non-accidental deaths, for cancer and non-cancer deaths.

## Results

Among the 431,735 adult deaths, hospitals were the most common PoD (47.3%), followed by care homes (23.1%), homes (22.5%), hospices (6.1%) and other places (1.1%). One-third (30.3%) of the deaths were caused by cancer and two-thirds (69.7%) were caused by non-cancer.

Almost all service categories analysed in this study contributed to some of the area-level variation in the PoD. Service type and capacity were the strongest predictors among all service categories, explaining 36.5–56.6% of the variation in hospital deaths, 47.8–73.8% of the variation in care home deaths, and a lower level (but still statistically significant) variation of deaths in hospices (14.2–21.7%) and at home (26.3–46.2%). Service location contributed to the variation in hospital and care home deaths, and its contribution was not as high as type and capacity variables but was statistically significant (10.8–34.1%). Service location was also related to CCG-level variation of hospice deaths (12.9–13.9%) but showed no effect at the LA level. Home deaths from cancer were associated with service location at both CCG and LA levels, but none of the distance measures reached a statistically significant contribution in non-cancer home deaths. Contributions of other service categories to variation in PoD were inconsistent.

The multilevel models developed using the service variables by individual service categories were mostly of poor performance in differentiating hospital or care home death from home death. Most AUCs were in the range of 0.5 to 0.6. Models built with service location variables for care home versus home death in cancer showed a fair predictive accuracy (0.684 to 0.687). For all deaths, the predictive performance provided by the service location was satisfactory [0.777, 95% confidence interval (CI) 0.774 to 0.780] in the care home versus home model. The service variables appeared more useful in predicting death in hospice than in hospitals or care homes, with most AUCs in the fair performance range of 0.603 to 0.691.

After controlling for the differences in the patient-level characteristics and each other's effects, the area-level service factors did not show strong independent effects on PoD. However, the effect was consistent across the CCG- and LA-level service attributes, and the direction of the effect was clear.

The distance to the nearest care facility was negatively associated with death in that facility, consistently so in both CCG- and LA-level models. The CCG-level number of hospices per 10,000 adults was associated with the significantly higher chance of hospice death (OR 24.22, 99% CI 1.53 to 382.59), but it appeared that the effect was driven by non-cancer deaths (OR 30.88, 99% CI 3.46 to 275.44). In cancer deaths, the hospice capacity was related to the slightly lower chance of hospice death. The distance to nearest hospital reduced the likelihood of care home death. The distance to the nearest hospice was related to a lower chance of hospice death. Service use variables showed no effect on hospital or hospice deaths, but the increased use of acute care (i.e. the mean length of stay in the accident and emergency department and mean number of occupied hospital beds) was negatively associated with care home death.

Among all of the examined interaction effects, only LA-level service factors interacted with each other and with sociodemographics to affect the chance of cancer patients dying in a hospital. The distance to the nearest care home influenced the effect on the number of care home beds, age and sex on hospital death, with  $p$ -values ranging from 0.0002 to 0.0026.

## Conclusions

This is, to date and to our knowledge, the first and largest national population-based evaluation study of health-care service factors and place of death. A link was found between area-level service factors (including commissioning, type and capacity, location, workforce, and service use) and the PoD. Hospice capacity was associated with a significantly higher chance of hospice death in non-cancer deaths but a slightly lower chance of hospice death in cancer deaths. The distance to the nearest care facility was negatively related to the probability of a patient dying in that care facility. The effect size of the service factors was small overall, but there was a significant interactive effect between the service factors, sociodemographic and clinical variables. This finding suggests that the high-quality end-of-life care needs to be built on service-level configuration tailored to individuals' circumstances. We identified a large data gap, which was partly due to a lack of attention and investment in this area, and urge for more national data collection on services relevant to palliative and end-of-life care. Owing to these data limitations, the findings need to be explored further in future investigations.

## Recommendations

Based on the findings, we make the following preliminary recommendations:

1. To develop a core set of national data, collected using a standardised approach and format, on services relevant to palliative and end-of-life care, particularly those that may facilitate/prohibit patients achieving their preferred PoD.
2. To support further research to validate the link between the capacity of care facilities and the PoD, and to understand why they have different impacts on cancer and non-cancer deaths, including how care facilities interact with various contextual and other service factors.
3. To support further research to validate the link between distance to health-care facilities as well as other geographical access measures (e.g. travel time, network measures) and the PoD, and how to address the inequality caused by limited geographical access.
4. To support research on the application of the research evidence to practices to improve palliative and end-of-life care, particularly in reducing inequality in care.
5. To support more evaluation research that helps to identify both health and social care services that contribute to the high quality of care at the end of life, in particular the studies involving routine data sources (e.g. Hospital Episode Statistics, Clinical Practice Research Datalink, other underused health and social care data) that can be used to investigate time trends, the trajectories of care outcomes, and social care and associated contextual factors.
6. To support research in expanding the evidence base on how health and social care service factors affect care outcomes beyond PoD (e.g. satisfaction, place of care, preference).

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