**Likelihood of Home Death Associated With Local Rates of Home Birth: Influence of Local Area Healthcare Preferences on Site of Death**

Maria J. Silveira, MD, MA, MPH, Laurel A. Copeland, PhD, MPH, and Chris Feudtner, MD, PhD, MPH

Despite most terminally ill patients’ wishing to die at home, two thirds die elsewhere.\(^1\)\(^–\)\(^5\) Of the many explanations for this inconsistency between desire and practice, the best-supported theory posits that the site of death is determined primarily not by the characteristics of individual patients or providers, but by characteristics of the local health system. As depicted in Figure 1 (as association 1), greater availability of beds in skilled nursing facilities and hospitals correlates with higher rates of deaths in those facilities,\(^6\)\(^,\)\(^7\) even after adjustment for individual characteristics such as age, gender, and marital status.\(^8\) Evidence also exists that individual characteristics may serve as logistical constraints on the ability to act on a wish to die at home, as people who are older, more functionally impaired, living alone, and suffering from more disabling diagnoses die more often in hospitals.\(^9\)\(^–\)\(^11\)

To understand why deaths occur where they do, one must disentangle the effect of system-level attributes from those of individual-level constraints and preferences. This is difficult. Complex interactions of individual and systemic attributes such as those listed affect the choices people face, the decisions they make, and their ability to act on these decisions. Cultural and social values probably also guide patients, families, and care providers.

Relatively homogenous and coherent sets of these values may be shared within local communities, either through a process of person-to-person dissemination of values or by people preferentially migrating to communities that manifest particular values. Community-level values regarding health care preferences may influence both choices to die at home and the availability and type of health services. Individuals operating within a culture that values hospitalization might seek or demand more hospital beds, or choose to reside in regions where more hospital beds were available, and thereby create an inflated association between bed availability and hospital deaths.

We examined the relation between local values and place of death depicted by association 3 in Figure 1. Because no direct measure was available, we used a proxy measure for local health care values. We sought a population-based parameter of health service use that, although having no clear relation to the proportion of deaths occurring at home, would also be affected by any local preference for or against medical care. We posited that the proportion of births occurring at home in a local area would serve as surrogate marker for a local preference against hospital care (depicted as association 2 in Figure 1). This model of the relation between home birth rates and preferences about hospital care accords well with findings from a detailed study of the Netherlands, where the high rates of home births and home deaths are at least in part because of cultural preferences for these modes of care.\(^12\)

**Objectives.** We tested whether local cultural and social values regarding the use of health care are associated with the likelihood of home death, using variation in local rates of home births as a proxy for geographic variation in these values.

**Methods.** For each of 351,110 adult decedents in Washington state who died from 1989 through 1998, we calculated the home birth rate in each zip code during the year of death and then used multivariate regression modeling to estimate the relation between the likelihood of home death and the local rate of home births.

**Results.** Individuals residing in local areas with higher home birth rates had greater adjusted likelihood of dying at home (odds ratio \([OR]=1.04\) for each percentage point increase in home birth rate; 95% confidence interval \([CI]=1.03, 1.05\)). Moreover, the likelihood of dying at home increased with local wealth (\(OR=1.04\) per $10,000; 95% CI = 1.02, 1.06) but decreased with local hospital bed availability (\(OR=0.96\) per 1000 beds; 95% CI = 0.95, 0.97).


Accordingly, we hypothesized that in geographic regions with higher proportions of home births, a death would be more likely to occur at home, even after adjustment for the decedent’s demographic factors and for the local hospital bed supply. We tested this hypothesis by examining the association between home births and home deaths in Washington state during the decade spanning 1989 through 1998.

**METHODS**

**Research Design and Outcome of Interest**

We conducted a retrospective population-based cohort study, the outcomes of interest being the person’s place of death and the local rates of home deaths. For analyses done at the level of the individual (henceforth referred to as individual analyses), the unit of analysis was the decedent. Home deaths were defined as those deaths occurring at the person’s primary residence. They were compared with deaths occurring elsewhere (e.g., hospital, nursing home, hospice facility). For analyses done at the group
level (henceforth referred to as the group analyses), the outcome was the rate of home deaths per zip code; this dependent variable was used in models that used zip code as the unit of analysis.

**Study Population and Data Source**

We examined the death certificates of 351,110 residents of Washington who died nontraumatic deaths after their 18th birthday during the interval from 1989 through 1998; individuals dying from injury or poisoning were excluded. We designed our selection criteria to identify those subjects most likely to have chosen both their place of residence and place of death. The analytic sample represented 86% of all deaths in Washington during that decade. We also examined Washington state birth certificates for the same period.

**Predictor of Interest**

The primary predictor variable was the rate (proportion) of home births in a residential zip code serviced by the US Postal Service in 1990. We omitted zip codes that consisted solely of post office boxes.

We determined home birth rates using birth certificate data for 767,082 live births occurring in 484 residential Washington zip codes during 1989 through 1998. Home births occurred at the mother’s primary residence, regardless of later transfer to a hospital. Home birth rates were determined by dividing the total number of home births by the total number of births for each zip code and multiplying by 100.

Because the demographics of decedents and new mothers differed greatly, and because maternal demographic characteristics partially reflect the characteristics of the community in which the decedent lived, we adjusted for maternal demographics (year of birth, mother’s marital status categorized as married and nonmarried, mother’s age, and mother’s ethnicity categorized as American Indian, Black, Hispanic, Asian, other non-White, or White), so that these effects would not be confounded with the effect of the cultural value we sought to capture in home birth rates.

A total of 744,319 birth records (95.7%) had complete data with the exception of mother’s educational level, which was excluded because of missing data (Washington state did not begin gathering this information until 1992; thus, 38% of birth certificates did not list the mother’s education). These factors were aggregated to the zip code level to permit linkage to individual decedent records by the zip code.

**Covariates**

Covariates included decedent, maternal, and geographic area factors. Decedents’ covariates in the model included year of death, race/ethnicity (categorized as White or non-White), age, gender, marital status (married or nonmarried), and leading causes of death (International Classification of Diseases, Ninth Revision, Clinical Modification codes for infectious diseases, 001–139; malignancy, 140–239; diabetes and complications, 250–250.9; cerebrovascular disease, 430–438.9; circulatory, 390–430, 440–459, 785.5–785.59; pneumonia, 480–487.6; chronic obstructive pulmonary disease, 490–496; gastrointestinal and liver, 520–579; renal and genitourinary, 580–599; injury and poisoning, 800–994.9). Geographic factors included median household income per zip code (1990 Census figures), population per zip code (1990 Census figures), and hospital bed availability.

Hospital bed availability was determined from 1990 American Hospital Association statistics counting the number of staffed hospital beds in each of 63 hospital service areas (HSAs) in Washington state. Briefly, HSAs are groupings of contiguous zip codes whose residents preferentially use a certain hospital. The number of hospital beds per HSA was modeled with population as 2 separate variables in our analyses, rather than as a ratio, to avoid autocorrelation. HSAs for Washington have previously been described. HSAs can be linked to their component zip codes and then, by zip code, with individual-level records. In this study, the mean population per zip code (in 10 000s) was 1.02 (SD = 1.19; range = 0 to 5.06). The mean value of the median household income (in $10 000s) per zip code was 2.84 (SD = 0.87, range = 0 to 6.16). The mean number of hospital beds per HSA (in 1000s) was 0.58 (SD = 0.89, range = 0.01 to 3.32).

**Individual-Level Analysis**

To analyze individual decedents’ place of death, we first determined bivariate associations between home deaths and categorical variables using \( \chi^2 \) analyses and between home deaths and continuous variables with Student \( t \) tests. We used Mantel–Haenszel \( \chi^2 \) to assess trends over time. We used logistic regression modeling to test the main hypothesis that local home birth rates would be positively associated with the likelihood of death at home, with adjustment for maternal characteristics (mothers’ average age, percentage married, percentage American Indian, percentage Black, percentage Hispanic, percentage Asian American, percentage
Group-Level Analysis

To analyze a local area’s home death rate, we first aggregated the death data to the zip code level by taking the mean age of decedents per zip code and the percentage of decedents characterized by each indicator variable per zip code. We then entered these zip code–level variables into a linear regression estimating the percentage of deaths occurring at home per zip code. In addition, we tested models including median income, population, and hospital bed availability, as described previously. We used zip codes as our geographic unit of analysis because it was the smallest geographic unit available and, thus, was more likely to capture local cultural variation than larger units such as counties. The sample for the group level analyses was 475 zip codes with complete data.

For all data analysis, we used SAS 8.2 (SAS Institute, Cary, NC) and Stata 7.0 (StataCorp LP, College Station, Tex).

RESULTS

Deaths

In Washington state from 1989 through 1998, 26% of adults who died because of nontraumatic causes did so at home. Dying at home became more common over the decade, increasing from 23% in 1989 to 28% in 1998 (P<.0001). Among zip codes in Washington, the percentage of home deaths during this decade ranged from 0% to 56.3%. As shown in Table 1, individuals who died at home were more likely to be male, married, Black, and less educated than those who did not die at home. Those who died at home were younger than those who died elsewhere (72 vs 76 years, P<.0001) and tended to suffer from cancer more often (40% vs 22%, P<.0001).

<table>
<thead>
<tr>
<th>Cause of death, %</th>
<th>Overall Mean or % (n = 351110)</th>
<th>Home Deaths (n = 92143)</th>
<th>Nonhome Deaths (n = 258767)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female, %</td>
<td>51</td>
<td>46</td>
<td>52</td>
</tr>
<tr>
<td>Race, %</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asian</td>
<td>1.9</td>
<td>2.0</td>
<td>1.9</td>
</tr>
<tr>
<td>Black</td>
<td>2.1</td>
<td>2.3</td>
<td>2.1</td>
</tr>
<tr>
<td>White</td>
<td>94</td>
<td>94</td>
<td>94</td>
</tr>
<tr>
<td>Other</td>
<td>43.8</td>
<td>49</td>
<td>42</td>
</tr>
<tr>
<td>Education, mean y (SD)c</td>
<td>11.9 (2.9)</td>
<td>11.8</td>
<td>12.1</td>
</tr>
<tr>
<td>Cause of death, %</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Circulatory disease</td>
<td>35</td>
<td>37</td>
<td>34</td>
</tr>
<tr>
<td>Malignancy</td>
<td>27</td>
<td>40</td>
<td>22</td>
</tr>
<tr>
<td>Cerebrovascular disease</td>
<td>9</td>
<td>3</td>
<td>11</td>
</tr>
<tr>
<td>Other causes</td>
<td>9</td>
<td>7</td>
<td>10</td>
</tr>
<tr>
<td>COPD</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>4</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Gastrointestinal/hepatic disease</td>
<td>4</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Diabetes and complications</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Infectious disease</td>
<td>2</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Renal disease</td>
<td>1</td>
<td>&lt;1</td>
<td>1</td>
</tr>
</tbody>
</table>

Note. COPD = chronic obstructive pulmonary disease.


Individual Likelihood of Home Death

In a multivariate logistic regression model (Table 2), individuals residing in zip codes with higher home birth rates had greater odds of dying at home (adjusted OR = 1.04; 95% CI = 1.03, 1.05; P<.0001), representing a 4% increased likelihood of home death for every percentage increase in the home birth rate. Thus, decedents in a zip code with 10% home births would have roughly a 40% increased risk of dying at home. The pseudo-R² for this model was 6.1%. Within the

Deaths

In Washington state from 1989 through 1998, 26% of adults who died because of nontraumatic causes did so at home. Dying at home became more common over the decade, increasing from 23% in 1989 to 28% in 1998 (P<.0001). Among zip codes in Washington, the percentage of home deaths during this decade ranged from 0% to 56.3%. As shown in Table 1, individuals who died at home were more likely to be male, married, Black, and less educated than those who did not die at home. Those who died at home were younger than those who died elsewhere (72 vs 76 years, P<.0001) and tended to suffer from cancer more often (40% vs 22%, P<.0001).

<table>
<thead>
<tr>
<th>Cause of death, %</th>
<th>Overall Mean or % (n = 351110)</th>
<th>Home Deaths (n = 92143)</th>
<th>Nonhome Deaths (n = 258767)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female, %</td>
<td>51</td>
<td>46</td>
<td>52</td>
</tr>
<tr>
<td>Race, %</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asian</td>
<td>1.9</td>
<td>2.0</td>
<td>1.9</td>
</tr>
<tr>
<td>Black</td>
<td>2.1</td>
<td>2.3</td>
<td>2.1</td>
</tr>
<tr>
<td>White</td>
<td>94</td>
<td>94</td>
<td>94</td>
</tr>
<tr>
<td>Other</td>
<td>43.8</td>
<td>49</td>
<td>42</td>
</tr>
<tr>
<td>Education, mean y (SD)c</td>
<td>11.9 (2.9)</td>
<td>11.8</td>
<td>12.1</td>
</tr>
<tr>
<td>Cause of death, %</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Circulatory disease</td>
<td>35</td>
<td>37</td>
<td>34</td>
</tr>
<tr>
<td>Malignancy</td>
<td>27</td>
<td>40</td>
<td>22</td>
</tr>
<tr>
<td>Cerebrovascular disease</td>
<td>9</td>
<td>3</td>
<td>11</td>
</tr>
<tr>
<td>Other causes</td>
<td>9</td>
<td>7</td>
<td>10</td>
</tr>
<tr>
<td>COPD</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>4</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Gastrointestinal/hepatic disease</td>
<td>4</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Diabetes and complications</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Infectious disease</td>
<td>2</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Renal disease</td>
<td>1</td>
<td>&lt;1</td>
<td>1</td>
</tr>
</tbody>
</table>

Note. COPD = chronic obstructive pulmonary disease.


Individual Likelihood of Home Death

In a multivariate logistic regression model (Table 2), individuals residing in zip codes with higher home birth rates had greater odds of dying at home (adjusted OR = 1.04; 95% CI = 1.03, 1.05; P<.0001), representing a 4% increased likelihood of home death for every percentage increase in the home birth rate. Thus, decedents in a zip code with 10% home births would have roughly a 40% increased risk of dying at home. The pseudo-R² for this model was 6.1%. Within the
range of home birth rates among Washington zip codes (0% to 26.3%), the predicted likelihood of home death ranged from 2.7% to 75.3%. Similar results were obtained when median household income, population, and hospital bed availability were removed from the model: the odds ratio for home birth remained 1.04, suggesting that income and bed availability do not affect the relation between home births and home deaths. The relation between home births and home deaths was equally strong when the analysis was limited to decedents with cancer (OR=1.05; 95% CI=1.04, 1.06).

When we repeated these analyses with home birth rates in HSAs, the magnitude of the association between home deaths and home birth rates remained statistically significant (adjusted OR=1.05; 95% CI=1.04, 1.06).

**Local Likelihood of Home Death**

In a linear regression model in which the home death rate per zip code was the primary outcome, home birth rates per zip code were significantly associated with the percentage of deaths at home (Table 3). The effect estimate for zip code home birth rates was 0.41, meaning that on average for each percentage increase in home birth rates, the home death rate increased by four tenths of a percent. The proportion of the variance in zip code home death rates accounted for by this model was 28.6% (adjusted $R^2=0.25$). Other significant factors were decedent gender, year of death, some causes of death, and median household income. HSA beds and population were again not significant predictors in this model.

**DISCUSSION**

Research into the geography of death in America has attempted to answer 2 questions. First, why, despite 9 out of 10 Americans preferring otherwise,5 do half die in institutions?5 Second, why are there regional differences in places of death, with higher rates of home death in the western parts of the United States compared with elsewhere?27-28

In the Study to Understand Prognoses and Preferences for Outcomes and Risks of Treatment study, patient preference had little association with the place of death.50 Consequently, research has explored the relation...
between the place of death and conditions beyond patients’ control. These conditions fall into 2 types: those pertaining to the individual and the home environment (such as age, race, diagnosis, gender, and caregiver status), and those of the local health system (such as the availability of hospital beds, the per capita supply of physicians, and local wealth). Two studies have examined regional differences in the relation between these factors and place of death, both with similar conclusions. Pritchard and colleagues used hospital referral regions as the unit of analysis to show that hospital bed availability is associated with the risk of in-hospital death after control for individual factors.

Most recently, Hansen and others conducted an analysis of deaths nationwide demonstrating that for every additional hospital bed per 1000 population, there is a 4.2% increase in the hospital death rate after adjustment for individual and other systemic factors. They confirmed these results at the state level, where greater hospital bed availability was associated with an increased likelihood of hospital death. On the basis of these findings, they concluded that “although we would like to believe otherwise, where we die is influenced less by our individual personal preferences than by factors outside our direct control.” In addition, various authors have suggested that fewer hospital deaths would occur if changes were made in the local health care system, for instance by increasing access to hospice or limiting hospital transfers.17,18

Although these observational studies demonstrate a relation between hospital bed availability and hospital deaths, they do not explain how or why this relation exists. Indeed, the inference that individuals make decisions regarding their location at the time of death on the basis of the local accessibility of hospital beds is premature and rests on a potential ecological fallacy: that hospital bed availability is a fundamental driver of place of death, rather than an epiphenomenon brought about by a heretofore hidden relation between an as-yet-unspecified causal factor and place of death. The question, couched in epidemiological terms, remains: is bed availability a main effect, a confounder, or an intermediate variable on a causal pathway?

We examined whether hospital bed availability and other systemic factors are best understood as links in the chain of causation between geography and place of death. Moreover, we posited that social factors, namely local preferences regarding medical care, would be the beginning of the chain. Our findings suggest that a local preference regarding medical care, measured by the surrogate marker of home birth, is associated with home death, albeit to a small degree.

The small effect of local home birth rates on the likelihood of home death that we observed has at least 3 potential explanations. First, the capacity of home birth rates to serve as an accurate proxy for the underlying construct of local cultural and social values may be quite limited, leading directly to an underestimation of the proposed relation, assuming it exists. Second, the proposed relation between local values and the rates of home births may be entirely invalid, implying that the observed correlation between home births and home deaths is driven by some unidentified third variable.

Third, rather than revealing a linear chain of causation, our results may instead suggest a “web of causation,” whereby home deaths in certain areas appear to be determined to different degrees not only by the local values but also by individual demographic and clinical factors and by characteristics of the local health system such as bed availability and local wealth, each acting independently and simultaneously. Any such complex causal web could attenuate or inflate an observed relation if any of the key “threads” in the web were omitted from the analytic model. This potential causal complexity may also explain why other studies have shown different results regarding the association between place of death and the decedent’s individual factors, such as gender and age.

Although we found that hospital bed availability was associated with hospital death at the individual level, the relation became insignificant at the aggregate level. This observation highlights a major challenge in conducting multilevel analyses, namely that correlations between variables can differ markedly in magnitude, and even direction, when analyzed at the individual and aggregate levels. Accordingly, multilevel analyses and inferences drawn from them should be based on causal models specifying how group-level and individual-level variables interact. Theories regarding place of death will need to be grounded through qualitative research in the real-life experiences of patients, their families, and their communities. For example, we note high rates of home deaths and home births for zip codes on island communities; qualitative research could determine whether home deaths or births represent choice or constraint of choice because of location. Additionally, better theories are needed about what constitutes community values: are they simply a composite of individual-level values of patients, family members, and healthcare providers, or do they represent more-complex emergent values that influence individuals but exist primarily at the level of communities?

Our study had 2 limitations that warrant discussion. First, having no established measure for local preferences regarding hospital-based medical care, we used home birth rates as a proxy marker because studies suggest that home birth is a culturally driven phenomenon. As argued previously, to fully appreciate the cultural connection between home births and home deaths, qualitative work is needed.

Second, we used zip codes as our unit of analysis. Zip codes were created to reflect postal routes, not the boundaries of neighborhoods and communities per se. Thus, some might argue that the relation we observed between home births and home deaths at the zip code level might be because of location rather than shared culture. Alternative units of analyses, such as census tracts or school districts, could be equally flawed. Although the ideal unit of analysis for this study—coherent communities—has yet to be geographically defined and developed, any failure of zip codes to map accurately onto cohesive local communities would most likely result in nondifferential misclassification, thereby having biased this study’s estimates of an association of local home birth rates and the likelihood of home death in a conservative direction.

Beyond these methodological issues, the practical question remains: what do we do to bring the experience of dying in America in
line with individuals’ stated preference to not die in a hospital? Do we work on structural features of the health care system, such as enhancing access to home care or building more hospices? Or do we intervene on psychosocial features of individuals, such as enhancing empowerment and knowledge of hospice? Our findings, if substantiated, and the considerations discussed earlier argue against a mutually exclusive focus on either systems or individuals. Reducing the proportion of people who die where they had not wanted to die is likely to require programs that address individuals, their society, and its cultural values, and the health system in which they reside. For this reason, we propose that the next step involve individual and community-level qualitative work to understand the causal mechanism behind place of death and identify factors amenable to reform.

We are indebted to Susan Dorr Goold, Patrick Heagerty, Dick Hoskins, and Tom Koepsell for their encouragement and comments.

**Human Participant Protection**

The institutional review boards at the University of Washington and the University of Michigan reviewed, approved, and supervised the conduct of this study.

**References**


**About the Authors**

Maria J. Silveira is with the VA Health Services Research and Development Center of Excellence, VA Ann Arbor Healthcare System, Ann Arbor, and the Division of General Medicine and the Bioethics Program, University of Michigan, Ann Arbor. Laurel A. Copeland is with the South Texas Veterans Health Care System VERDICT Research Program, San Antonio, and the Department of Psychiatry, University of Texas Health Science Center, San Antonio. Chris Feudtner is a member of the Pediatric Advanced Care Team, The Children’s Hospital of Philadelphia, Philadelphia, Pa; the Pediatric Generalist Research Group, Department of Pediatrics, Center for Bioethics, Leonard Davis Institute, Philadelphia, and Center for Clinical Epidemiology and Biostatistics, University of Pennsylvania, Philadelphia.

Requests for reprints should be sent to Maria J. Silveira, 300 North Ingalls Building, Room 7C27, Box 0429, Ann Arbor, MI 48109-0429 (e-mail: mariaj@umich.edu).

This article was accepted July 17, 2005.

**Contributors**

M.J. Silveira and C. Feudtner originated and designed the study and co-wrote the article. M.J. Silveira obtained the data and, along with L.A. Copeland, refined and conducted the analyses. All authors contributed interpretation of the analyses and critical review and revision of article drafts.

**Acknowledgments**

Members of this project team were supported by the Life Sciences Values and Society Program at the University of Michigan, the Robert Wood Johnson Clinical Scholars Program, The Robert Wood Johnson Faculty Scholars Program, the VA Health Services Research and Development Center of Excellence, and the Agency for Healthcare Research and Quality (grant KO8-HS000002).