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Preliminary Investigations of Hospital Geography and Patient Choice in Iowa

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This report provides a spatial representation of hospital geography in Iowa and of the decisions of patients to patronize hospitals. It begins with a brief analysis of hospital proximity and hospital proximity's relationship to population distributions and existing hospital capacity. This is followed with a discussion of hospital capacity as a proxy for the supply of hospital services and the construction of hospital service area gravity models based upon capacity. Patient patronage of hospitals is then presented as a proxy of demand for hospital services, and gravity models are estimated on the basis of patronage.

Having defined proxies for both the supply of and demand for hospital services and estimated patronage areas with respect to both, the analysis then turns to an investigation of where patients actually go for health care services. A simple visual analysis is done by mapping patients' locations of residence and coding residence points to identify hospitals actually visited. The next step is to informally evaluate the expectation that patients will patronize their local (within an estimated service area) or nearest (if they reside outside of any service area) hospital. This is done with respect to type of patient (inpatient or outpatient) and by type of diagnosis.

This investigation is based on hospital proximity, size, and patronage rather than qualitative evaluations of healthcare adequacy. Evaluation of health care quality is beyond the expertise of the authors. The analysis is based on visual interpretations and simple groupings of mapped data rather than on geostatistical analysis. The results provide a preliminary evaluation of data sources that have not previously been examined in detail. These preliminary results may identify areas of interest for further study.

Data was obtained through the 2002 Iowa Hospital Association Inpatient and Outpatient Databases, which provide information on actual patient patronage of Iowa hospitals. Patient patronage reveals individual decisions made in the context of current health care pricing, quality, and availability.

A Hospital Geography

Map 1 shows the locations of Iowa hospitals. For clarity of presentation and analysis, multiple hospitals in a single community are represented as a single hospital cluster. Hospitals and hospital clusters on the map are numbered. A list of hospital names and numbers is contained in Appendix 1. The background of Map 1 is a dot-density map of population densities throughout the state. This provides a reference for linking hospital locations with population centers. Once hospital locations are identified, areas around hospitals and hospital clusters [1] can be defined. Among the several variables that these areas can be based upon are hospital proximity, capacity, and utilization.

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[1] Throughout the remainder of this paper the term "hospitals" will refer to both individual hospitals and to groups of hospitals clustered in a single community.

Map 1: Iowa hospital locations

Map 1: Iowa hospital locations

Hospitals

Population:
· 1 Dot = 100 people
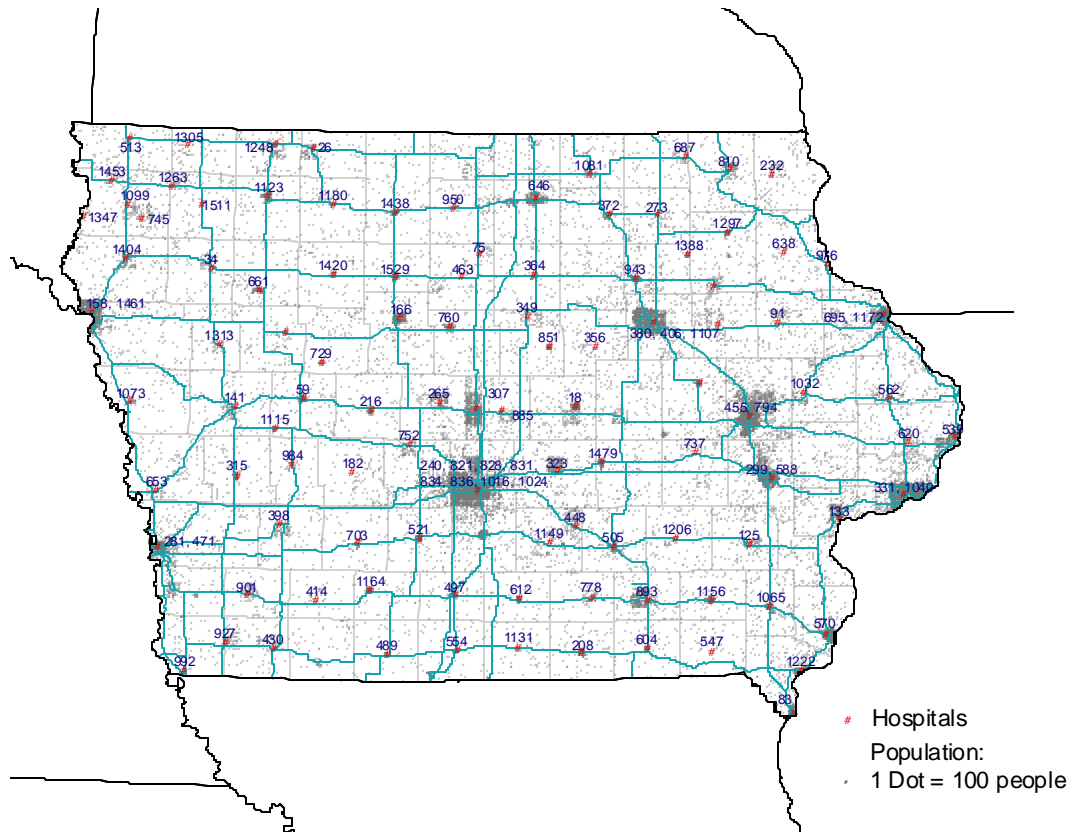
Proximity-based Areas

Map 2 begins to define hospital areas on the basis of simple linear proximity to the nearest hospital.[2] The red outlined polygons in Map 2 show the points that are equidistant between adjacent hospitals.[3] If we expect individuals to make hospital patronage choices solely on the basis of linear distance, these polygons define the frontiers of hospital areas in the state.[4]

Notice that the polygons along the edges of the state do not follow the State of Iowa's borders. To fairly represent the influence of hospitals at the edges of bordering states, a population of surrounding-state hospitals was included in the geographic dataset. This bounded the Iowa hospitals in border areas, allowing a consistent representation of geographic proximity, capacity, and utilization for each hospital within Iowa's borders in the analyses.

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[2]   These calculations assume that the hospitals within any center are located precisely at the center of the dominant community.

[3]   These polygons are referred to as "Veroni Diagrams" or "Thiessen Polygons" in the literature of Geographic Information Systems.

[4]   This is a simplification of reality. In areas with regular rectangular road grids, right-angle distances are more accurate estimates of actual travel distance than are linear distances, but they are much harder to map and complicate the visual analysis. Also, the operational constraint upon travel in most instances is time rather than space. Incorporating travel time into the presentation, however, would require the assignment of speed variables to individual travel corridors, adding significant complexity to the analysis. Such complexity is warranted in some investigations, but it is beyond the scope of this effort.

Map 2. Equidistant proximity areas around Iowa hospitals
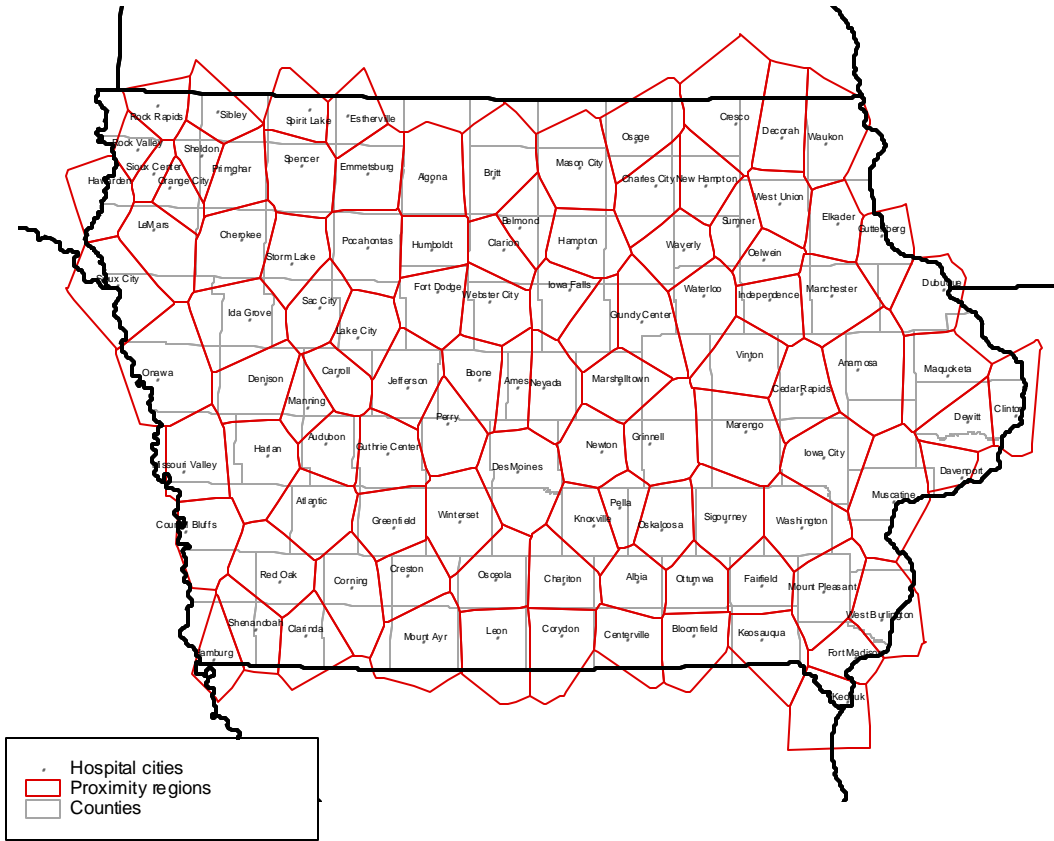
Population Distribution Among Proximity Areas

Map 3 expands upon Map 2 by adding population ranges to the proximity areas. Proximity areas are grouped into three categories based on population. Among the 105 hospital areas analyzed, 39 areas have total population under 12,500; 45 areas have total population between 12,500 and 25,000; and 21 areas have total population of 50,000 or more. Higher concentrations of population are evident in eastern Iowa and in other areas surrounding the state's metropolitan cities. Low-population areas form a large "C" shape across the map of Iowa, with another group clustered in northwestern Iowa.

In 2000, the total population of Iowa was 2.93 million. The total population within the Iowa hospital proximity areas is slightly larger (2.96 million), as the areas occasionally cross state borders. Summed together, areas with populations of less than 12,500 contain 12.4 percent of the 2.96 million people residing in the hospital areas statewide. The areas with 12,500 to 25,000 residents contain 26.8 percent of the total population. The most populous areas contain 60.7 percent of the total population. Table 2 summarizes the population shares, patient bed shares, and shares of inpatient and outpatient activity among these hospital area groups.

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Map 3. Population size of hospital proximity areas
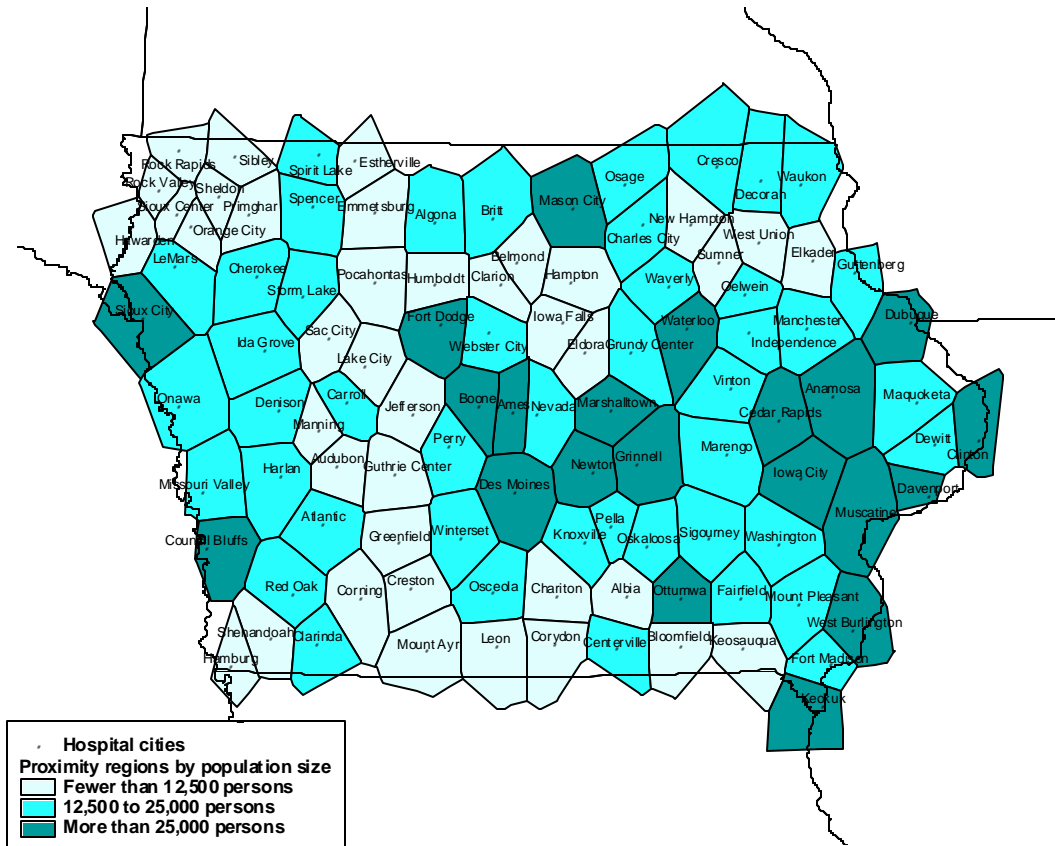
Table 2 shows that area hospital capacity (measured in terms of patient beds) does not necessarily reflect the population of an area. This becomes clear when we compare ratios of available hospital beds to population (in thousands) for each population group.

- Areas with fewer than 12,500 residents average 3.02 beds per 1,000 persons.
- Areas with 12,500 to 25,000 residents average 2.31 beds per 1,000 persons.
- Areas with more than 25,000 residents average 5.00 beds per 1,000 persons.

The distribution of inpatient visits to Iowa's hospitals is heavily skewed toward the most populous hospital areas. These areas have 75.3 percent of patient beds, but they posted 82.2 percent of total inpatient days. The distribution of outpatient visits more closely approximates the distribution of beds, with the most populous hospital areas posting 77.5 percent of outpatient visits. These differences suggest the existence of specializations and scale economies among hospitals in Iowa.

Map 4, regroups hospital proximity polygons into three categories based on hospital capacity. There are 70 low-capacity areas containing fewer than 50 patient beds; 21 mid-capacity areas with 50 to 100 beds; and 14 high-capacity areas with more than 100 beds. Defined in this manner, 31.4 percent of the study region population resides in a low-capacity area. Another 16.2 percent of the population resides in a mid-capacity area. The remainder, 52.3 percent, lives in a high-capacity area. Patient activity was distributed among the three groups as follows:

- Low-capacity areas had 12.1 percent of total inpatient days and 15.0 percent of outpatient visits.
- Mid-capacity areas had 10.0 percent of total inpatient days and 12.7 percent of outpatient visits.
- High-capacity areas had 78.0 percent of total inpatient days and 72.3 percent of outpatient visits.

Table 2. Population, capacity, and utilization by proximity areas

Percentage Shares of Study Region Totals	Population Size of Area		
	Under 12,500	12,500 to 25,000	More than 25,000
Population	12.4	26.8	60.7
Patient Beds	9.3	15.4	75.3
Inpatient Days	6.0	11.8	82.2
Outpatient Visits	7.6	14.9	77.5

Map 4. Hospital capacity by proximity areas

Hospital cities
Proximity regions by capacity in beds
Fewer than 50 beds
50 to 100 beds
More than 100 beds
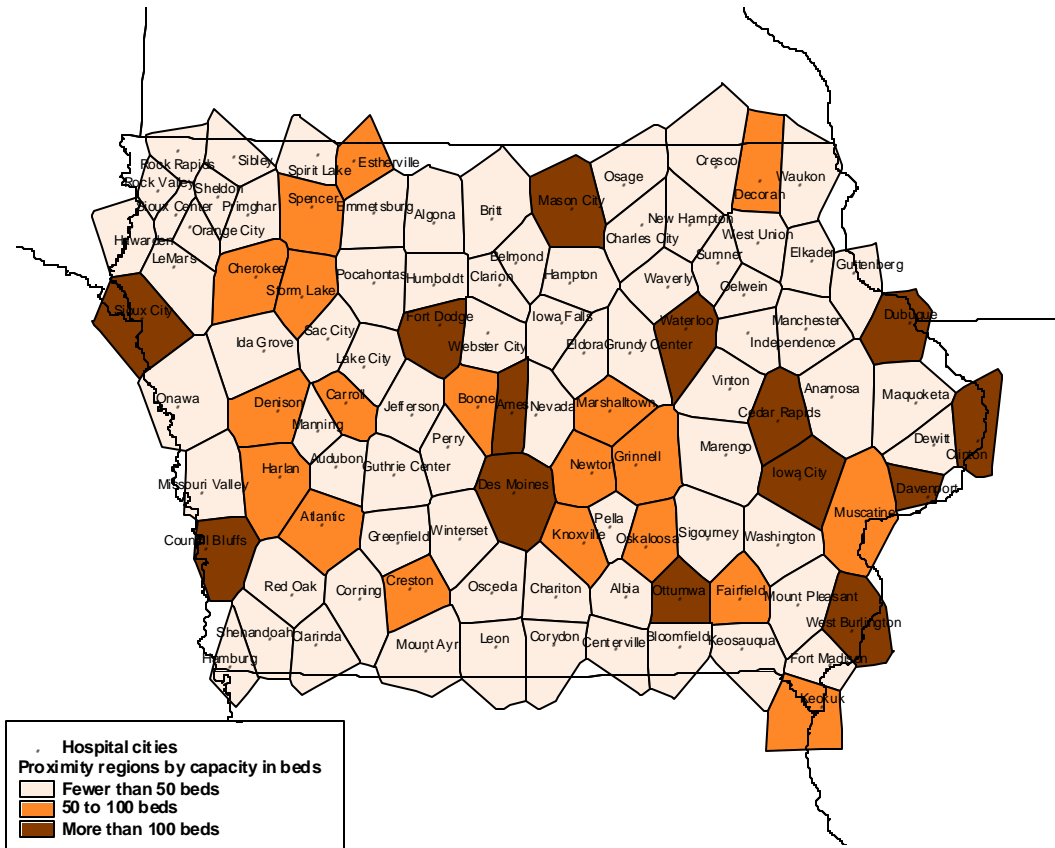
Capacity-based Areas

Map 5 includes the equidistant areas from Map 2 but replaces the background county grid with hospital capacity areas based on the number of hospital beds at any hospital and the distance between hospitals. These hospital capacity areas were estimated with a gravity model. Gravity models are regularly used to develop and analyze market areas in the retail trade industry and to analyze issues in economic development.

Gravity models are named because they assume that a potential patron's attraction to a retail outlet or hospital behaves similarly to the attraction of an object in space to the gravitational pull of a planet. The gravitational pull of a planet is a function of planet size or density. The effect of that gravitational pull on an object in space depends upon the distance between the object and the source of gravity. Gravity models

are directly analogous. The larger the hospital, the stronger its assumed pull on potential patients. The greater the distance between any individual patient and the hospital, the lesser the effect this pull has upon the patient.

The model estimates the probability that a potential patient in any given location will be drawn to a particular hospital based on hospital capacity (number of beds) and patient distance from the hospital. Wherever the likelihood of a patient at any location patronizing a given hospital is greater than 50 percent, that location is included as part of the given hospital's estimated capacity area. These capacity areas are represented by the colored amoebae-like shapes on Map 5. The colors differentiate the capacity areas, by number of beds. Areas outside of these amoebae-like shapes represent locations where the potential patient has several options, none of which has a probability of greater than 50 percent, or where the potential patient is expected to patronize an out-of-state hospital. A brief technical discussion of how these models were constructed is included in Appendix 2.

Map 5: Hospital areas by proximity and capacity
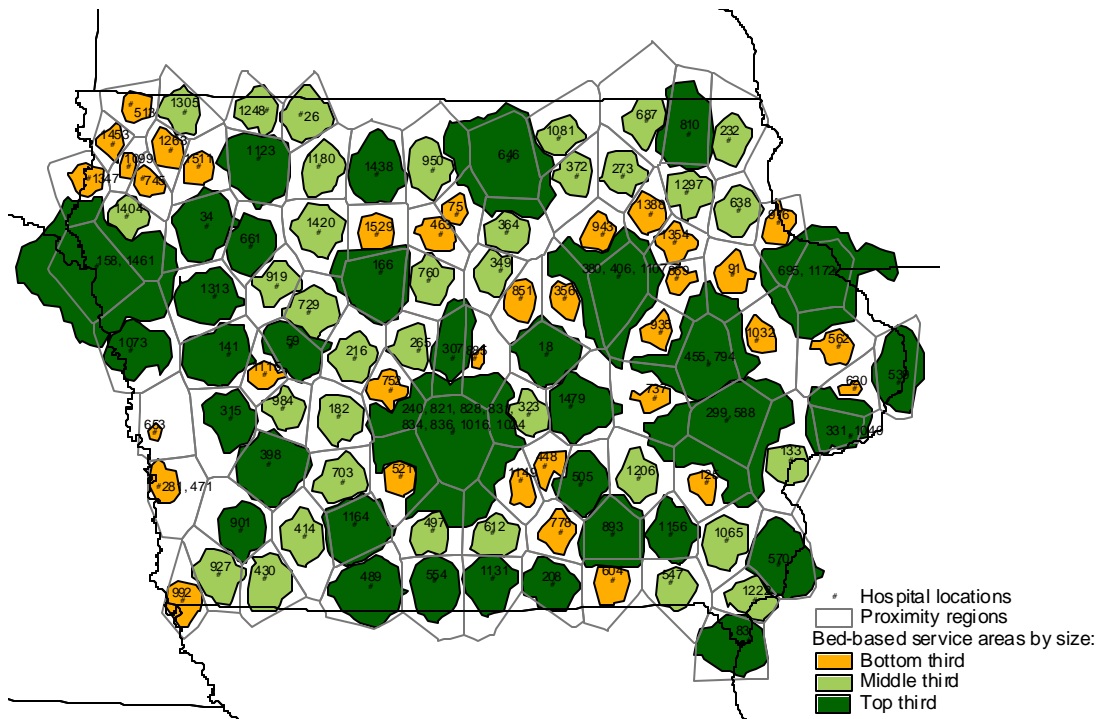
Using the number of beds as the attractive variable in this gravity model assumes that number of beds is a suitable proxy measure for hospital capacity and local hospital capital investment. There are limitations with this assumption. No attempt is made to account for patient outcome statistics, cost or quality of care, quality of facilities, or the technical adequacy of equipment and staff. On the other hand, number of beds is easy to obtain, easy to understand, and appears to be a good baseline from which to start the analysis.

Map 6 resolves the amoebae-shaped proximity areas presented in Map 5 to township-level areas. Census population data can then be attached to the areas. Appendix 3 provides numbers of hospital beds, patient-days, and areas (in square miles) and populations for both capacity-based and utilization-based areas.

Utilization-based Areas

The capacity areas displayed in maps 5 and 6 assume that every potential patient is aware of all hospital locations (distance) and capacities (beds available). The model for Map 7 drops hospital capacity as the attraction or gravity criterion and replaces it with a measure of hospital utilization (number of inpatient-days per year). This changes the source of attraction from decisions made by hospitals (provision of beds) to decisions made by other potential patients (hospital selection), changing the geographic context from hospital service supply to hospital service demand.

Map 6: Capacity areas resolved to the township level
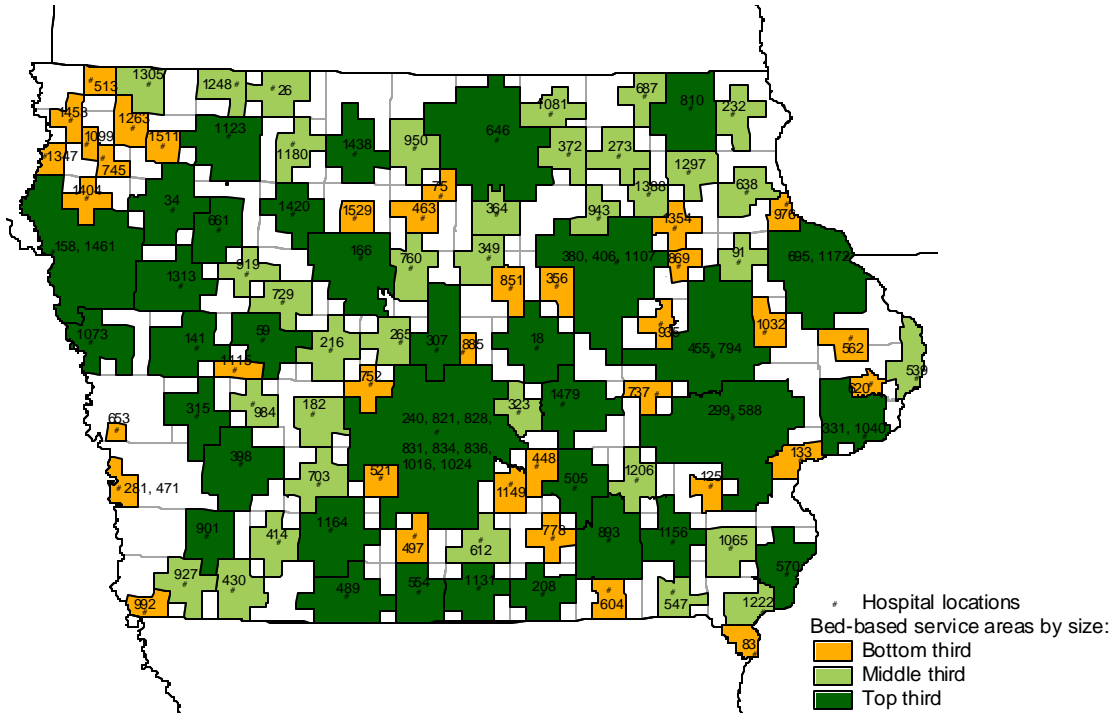
Map 7[5] shows hospital utilization areas by total inpatient-days. At a quick glance, you might not notice a great deal of difference between the areas defined by maps 5 and 7. If you look more closely, however, particularly at the interfaces between the relatively small (orange) areas and larger (green) areas, you will see several instances where hospitals have moved up or down the relative size scale as we move from capacity to utilization measures of attraction for the gravity model. The difference in the two representations shows the extent to which hospital patrons are electing to patronize or to bypass local hospital facilities. As with retailing, commuting is a growing issue with rural healthcare providers.

Like Map 6, Map 7 could be resolved to the township level, allowing us to attach Census population data to approximations of the area estimations. This is done in Map 8.

Map 9 combines information provided in maps 6 and 8. The geographic area boundaries in Map 9 are the township resolution of the capacity areas from Map 6. The color gradients in Map 9, however, do not indicate hospital size. Map 9 differentiates hospital areas by hospital utilization rates. To obtain these rates

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[5]   Map 7 and all of the maps that follow make it obvious that the Eldora hospital (number 851) in Hardin County is listed as having beds in 2002 but reports no patient visits.

total inpatient days per year were divided by total bed-days (365 times total available beds). The map shows eleven hospital areas with utilization rates of 50 percent or more and 34 hospital areas with utilization rates of less than 20 percent.

Map 7. Hospital utilization areas defined using total inpatient-days
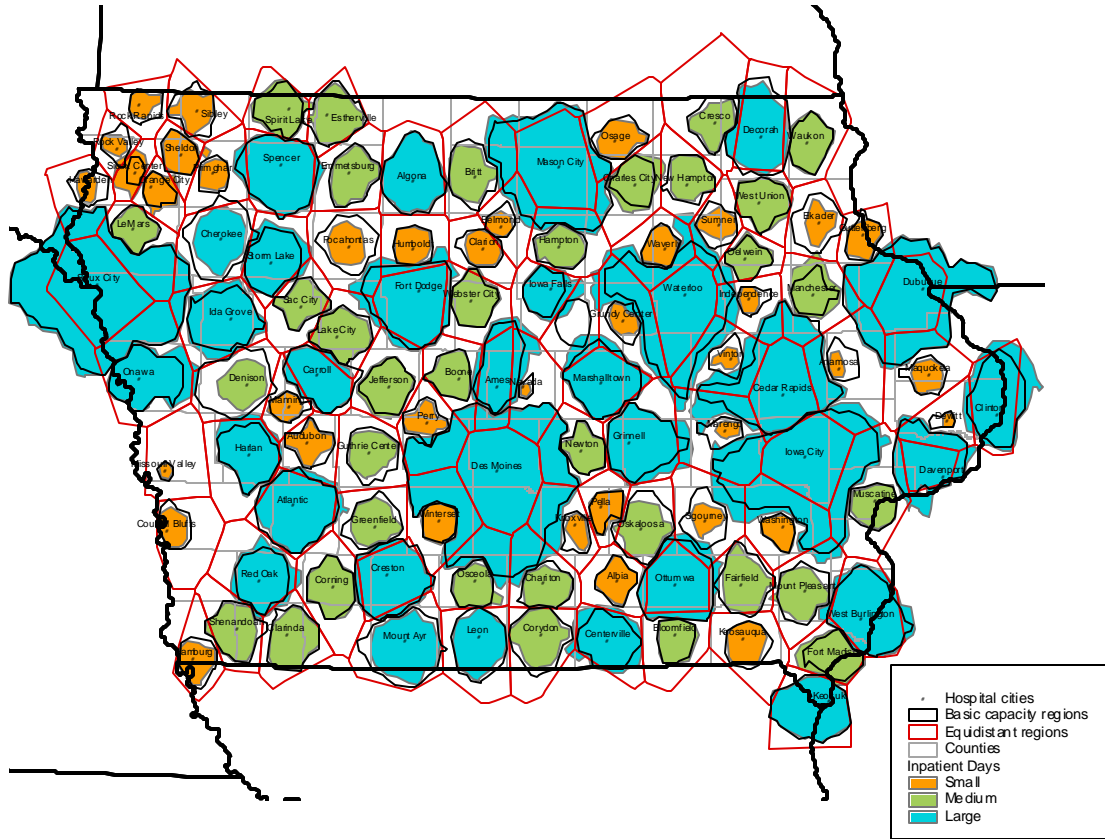
Appendix 3 provides underlying data on total inpatient days, capacity and utilization rates. Utilization rates were calculated by dividing total beds times 365 (days per year) into total inpatient days. Calculated rates range from zero for the hospital in Eldora (which is not included in Appendix 3) to 101 percent for the hospital in Sioux Center. The statewide hospital bed utilization rate is 37.5 percent for inpatient-days relative to available bed-days.

Comparing Capacity-based and Utilization-based Areas

Mapping capacity utilization ratios provides a simple way to evaluate the value of hospital capacity investments. Another way is to overlay estimated capacity areas and estimated utilization areas and compare the extent of area overlaps. Looking back at Map 7, you will see that this has been done.

For either of the gravity models, the estimated areas for any hospital represent the relationship between the capacity or utilization of that hospital and all of the other hospitals in the state. Moreover, the differences in the capacity and utilization areas for any hospital illustrates the relative strength of one over the other with respect to the geographic utilization and capacity areas estimated for every other hospital in the state. This follows from the fact that the distance grid used in both gravity model layers is the same, so the rate at which attractive values decay does not change between them. What does change is the measure of

attraction itself. For the capacity areas, the attractive variable used is number of beds, a proxy for overall hospital capacity and a measure of provision or supply. For the utilization areas, the attractive variable is inpatient-days, a measure of utilization or demand. Layering these areas provides a simple visual estimation of the relationship between spatial supply and demand for any hospital or the relationship between spatial supply or spatial demand between any hospital and all the other hospitals in the population.

Map 8: Utilization (patient-day) areas resolved to the township level
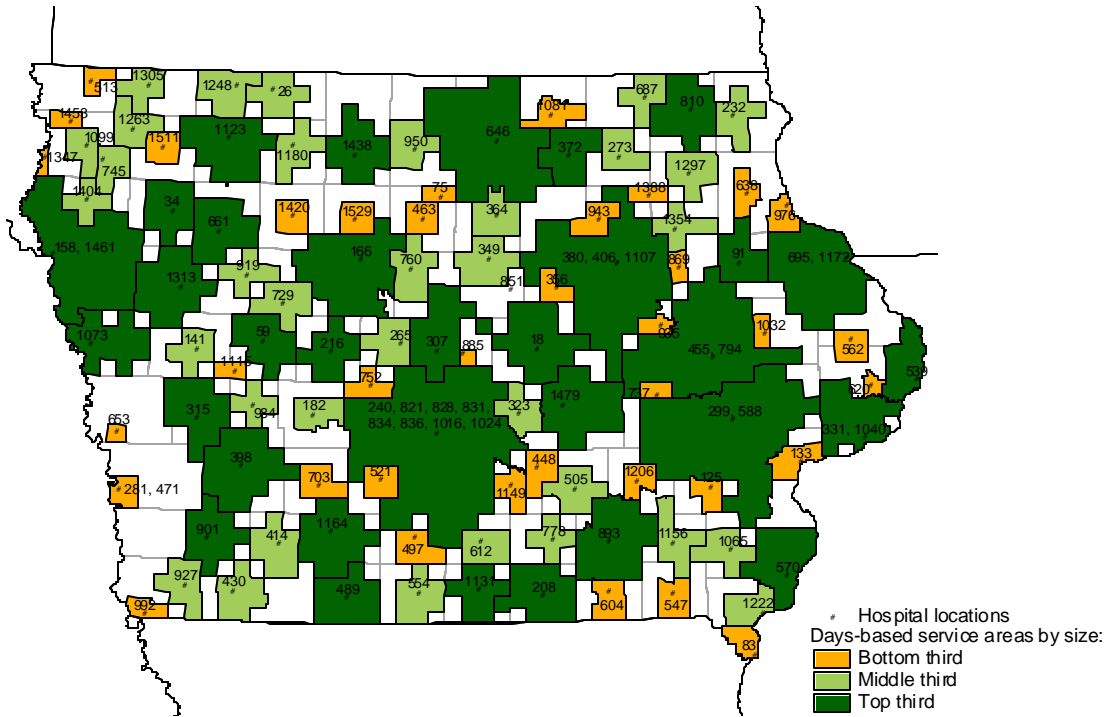
Understanding Map 7 in this way provides the ability to interpret the differences in any hospital's capacity and utilization areas in a manner similar to reading a graph. Look at the distance from an area's hospital center (the identified city) to the edge of the area in any direction. This provides a measure of the strength of that hospital center's estimated ability to attract patients relative to the estimated attraction of every other hospital center that exists in that general direction. For the two area estimates or boundaries in Map 7, capacity (supply) and utilization (demand), the distances from center to boundary can be compared along any radial vector. Along any radial vector, this provides a comparison of the relative strengths of the individual hospital's spatial supply and demand estimates relative to the estimated spatial supply and demand estimates of all other hospitals in the general direction of that radial vector.

Where the utilization area extends past the basic capacity area on any radial vector, the strength of that hospital's estimated spatial demand for services (relative to all other hospitals in a direction impacted by that radial vector) exceeds the strength of the hospital's estimated spatial supply of services (again, relative to all other hospitals in a direction impacted by that radial vector), and vice versa. It does not, however, provide a measure of the adequacy of supply or demand for any hospital center.

The radial distance from a given hospital to its area boundary can expand (contract) for two reasons. The first possibility is that the attractive variable can increase (decrease) for the given hospital at a greater (lesser) rate than it increases (decreases) for all of the other hospitals that affect that vector. The second possibility is that the attractive variable for all of the other hospitals that affect that vector can decrease (increase) at a greater (lesser) rate than it decreases (increases) for the given hospital. Map 7 shows relative strength of attraction between and among hospitals. It does not show adequacy or inadequacy of either supply or demand.

Also, the measures used as proxies for supply and demand (number of beds and number of inpatient days) used in Map 7 are crude. While both are useful in the aggregate, neither has the specific information needed to decide on the viability or quality of individual hospital services or overall health care sufficiency in an area. Visualizing differences on the maps should be only a first step in investigating the adequacy of either supply of or demand for services in any direction from a hospital.

Map 9: Capacity areas ranked by utilization rates
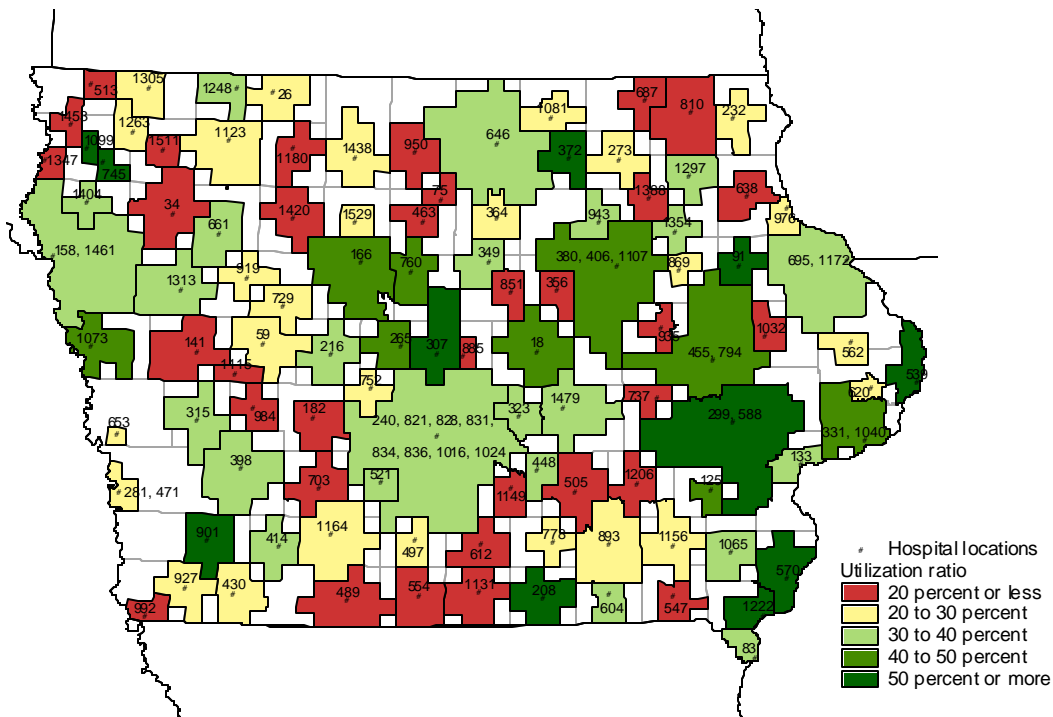
This type of visual analysis could also be done using outpatient visits or either inpatient or outpatient visits by diagnosis, primary procedure, or outcome as utilization proxies. On the capacity side, the analysis could be done with respect to hospital or public health budgets, number of staff, individual procedure capacities, etc. Appendix 4 provides supporting information on total inpatient visits, inpatient-days and outpatient visits for every hospital reporting activity. Appendix 4 also shows the percentage of each of these activities that originate within each hospital's estimated capacity area. This provides an initial perspective of the size of the population that is choosing on a basis that is consistent or is not consistent with the attraction and distance variables of the capacity-based gravity model.

Appendix 5 provides area in square miles and population for each of the hospital areas on the basis of capacity, inpatient days and outpatient visits. Appendix 5 also provides this information on the basis of inside-Iowa-only area size and populations. Populations were obtained for each hospital capacity and utilization area by resolving the estimated areas to the township level (maps 6 and 8). Where a township center fell within a service area, that township's population was credited to that service area. While this does not provide a perfect representation of area population, township distributions are the best and most finely divided regular allocations of population available for most rural areas.

Appendix 6 gives in-Iowa population and hospital bed information for each area as a percentage of Iowa totals. This provides a numeric representation of the relative strength of the capacity variable (hospital center beds) with the relative size of populations within both the estimated spatial supply and estimated spatial demand areas. Comparing the population ratios with the bed ratios provides an indication of the

relative adequacy of local supply and potential demand in any area. This provides another avenue to identify areas for further investigation. These comparisons, in themselves, however, do not provide definitive conclusions regarding the adequacy of either service capacity or utilization. Differences may exist because of large areas (and associated populations) with indeterminate patronage probabilities between contiguous hospitals, because of specific objectives of hospital management with respect to areas served or with respect to areas being contested, because of patient evaluations of hospital acceptability based on factors other than availability and distance, etc.

Patient Choice

Maps 5 through 9 display behaviors expected from potential patients based on the assumptions of the gravity model. The extent to which actual patient choices deviate from the expected behaviors may reveal patterns for further analysis. Map 10, for example, illustrates how observed patient choices align with expected hospital service areas in Northeast Iowa. The patient choice data were obtained from the Iowa Hospital Association 2002 Inpatient Database, which attaches patient residence by zip code with hospital patronage. In Map 10, each dot represents ten patient days corresponding to a zip code of patient residence (location of the dot) and hospital utilized (color of dot). Each hospital's estimated capacity area (see Map 5) is also included to provide an easy comparison of the actual and expected behaviors of potential patients.

It is clear from Map 10 that hospital patrons living within an estimated hospital service area often patronize hospitals outside of their local areas. Patrons who do not live within any defined service area may or may not patronize the nearest hospital. Building from the example in Map 10, maps 11 and 12 provide simplified, statewide pictures of the relationship between hospital proximity and the patronage choices made by Iowa residents in 2002. Each dot on these maps represents five inpatient visits (Map 11) or five outpatient visits (Map 12) by the zip code of patient residence. Dots are colored according to where the residents of a particular area chose to obtain service.[6]

- Red dots indicate residents who live within a hospital capacity area who patronized their local hospital (In-In).
- Yellow dots indicate residents who live within a hospital capacity area who patronized a nonlocal hospital (In-Out).
- Blue dots indicate residents who do not live within a hospital capacity area and did not patronize the hospital located nearest to their residence (Out-Far).
- Pink dots indicate residents who do not live within a hospital capacity area and did patronize the hospital located nearest to their residence (Out-Near).

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[6] Residents are credited to a hospital capacity area if the center of their residential zip code area lies within the capacity area. Dots, however, are placed randomly within the zip code areas. As a result, dots from zip code areas split by capacity area boundaries sometimes are placed on the wrong side of the relevant capacity area boundary. Where this happens, the color of the dot takes precedence over location.

Map 10: Patient-days by hospital area for northeast Iowa

West Union
1 Dot = 10
Waverly
1 Dot = 10
Waukon
1 Dot = 10
Sumner
1 Dot = 10
Oelwein
1 Dot = 10
New Hampton
1 Dot = 10
Manchester
1 Dot = 10
Independence
1 Dot = 10
Guttenberg
1 Dot = 10
Elkader
1 Dot = 10
Decorah
1 Dot = 10
Cresco
1 Dot = 10
Dubuque
1 Dot = 10
Waterloo-Cedar Falls
1 Dot = 10

C

12
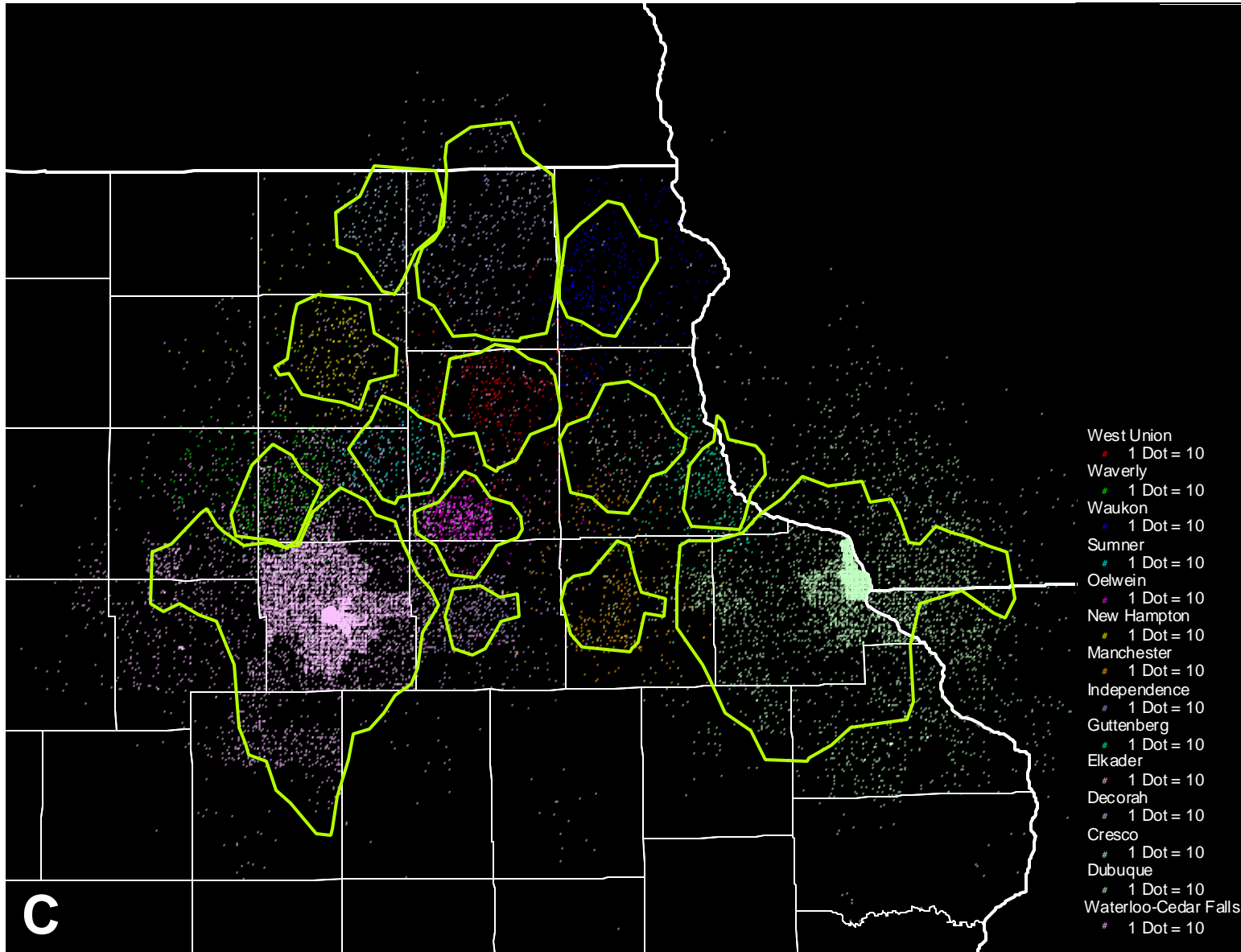
Map 11: Inpatient choice relative to hospital capacity area residence

Inpatient Visits

In - In (70.0%)
In - Out (19.2%)
Out - Far (8.2%)
Out - Near (2.6%)
1 dot = 5 visits
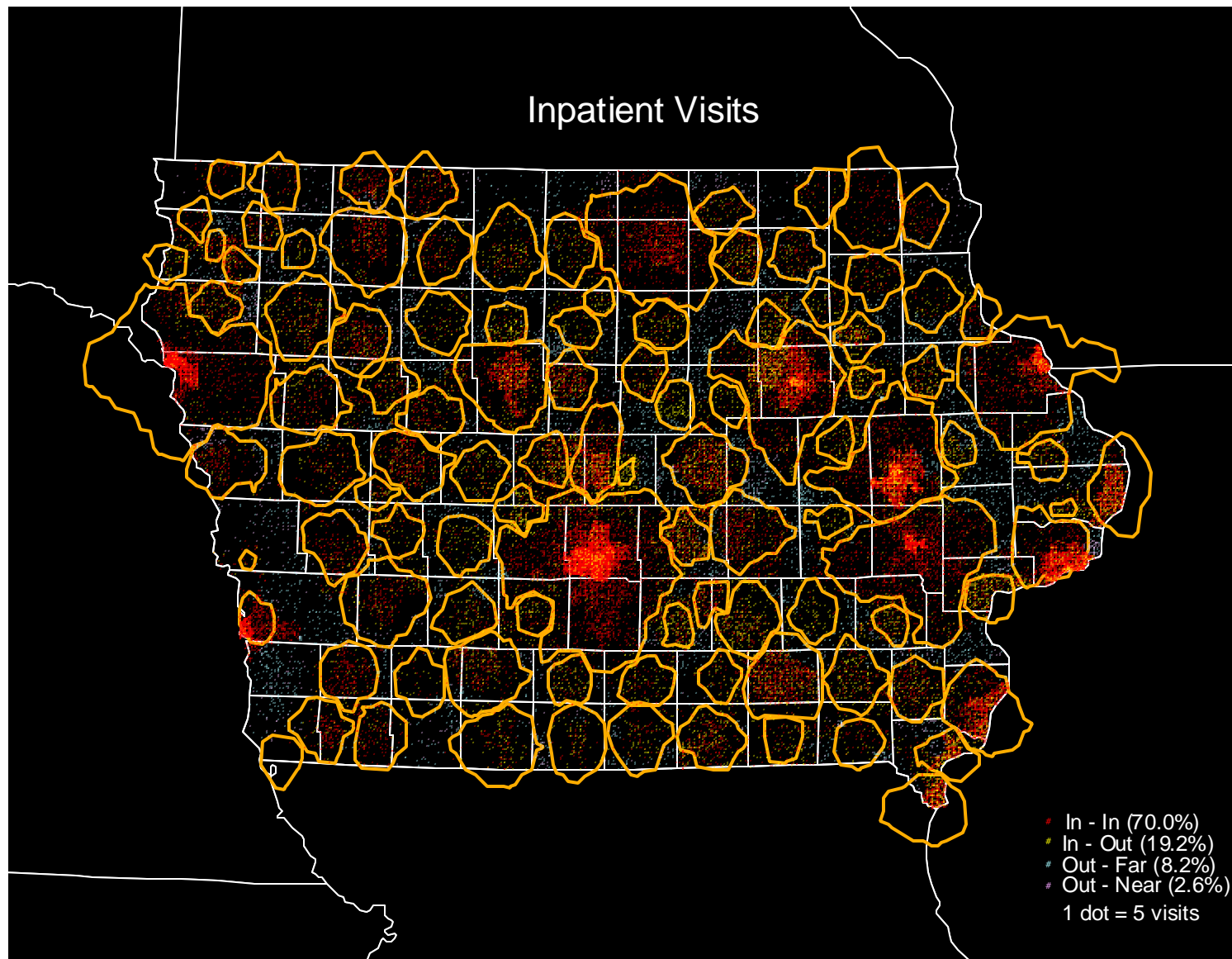
Map 12: Outpatient choice relative to hospital capacity area residence

Outpatient Visits

In - In (66.1%)
In - Out (22.6%)
Out - Far (8.4%)
Out - Near (2.9%)
1 dot = 5 visits
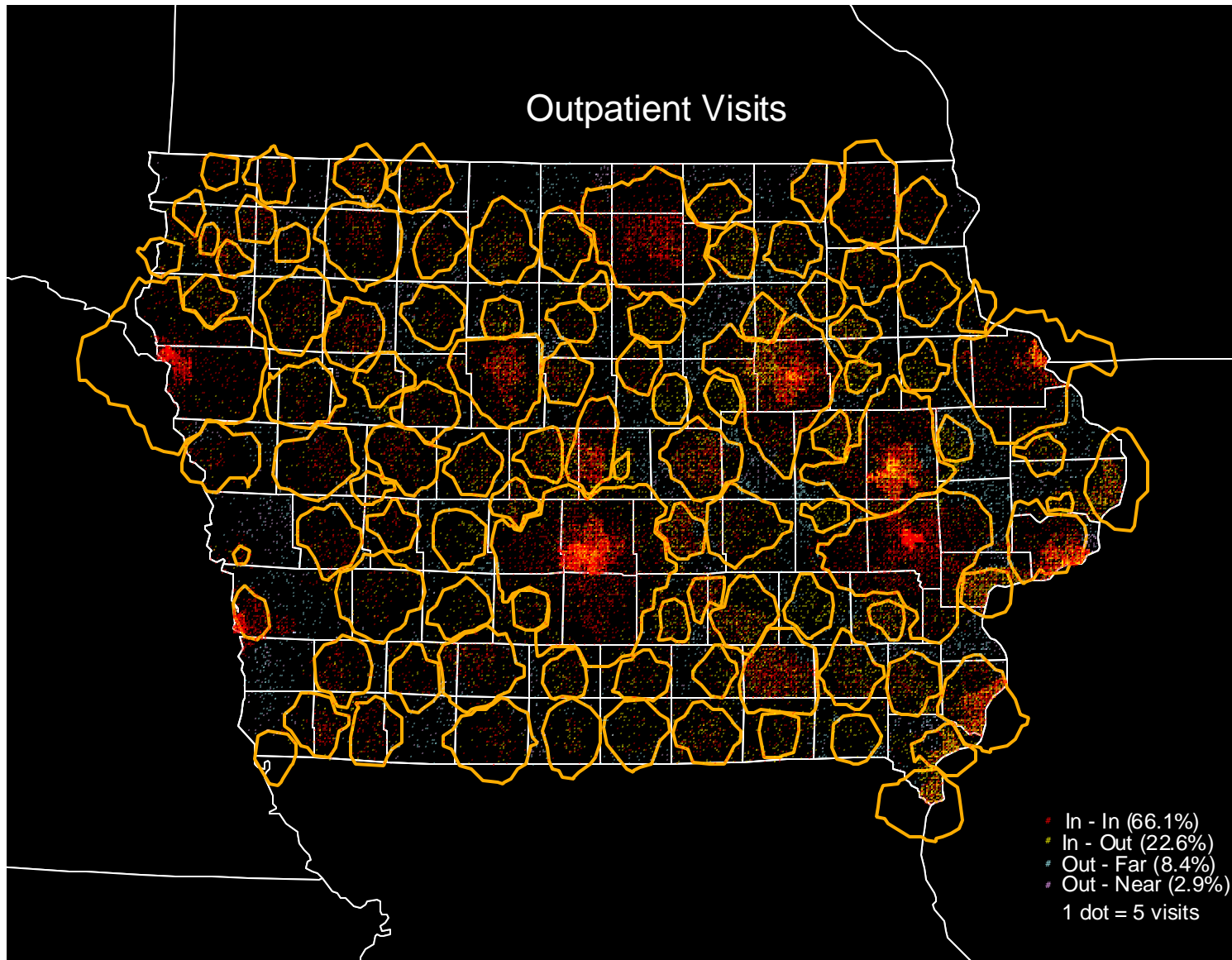
In both maps, red predominates in mid-to-large capacity hospital areas, and yellow predominates in many smaller capacity areas[7]. This would be a preliminary indication that patient commuting between hospital areas is more pronounced for smaller capacity areas. This is consistent with an assumption that health care commuting has a basis in both the comprehensiveness of the care and the convenience to the patient. Larger capacity areas undoubtedly provide a more comprehensive service set within a convenient distance of most area residents, reducing the incentive to out-commute relative to residents of small-capacity areas.

While the distribution of red and yellow dots speaks to the comprehensive-care basis of patient choice, the distribution of blue and pink dots speaks to the convenience basis of that choice. Residents who do not live within a health care capacity region display only about a one-in-four probability of patronizing their nearest hospital center. There are only minimal recognizable pink areas on either map. Living outside of an estimated capacity region means that there is less than a fifty percent choice that a patient will select a given hospital on the basis of its nearness and capacity. This nearly assures that the patient's residence is in an area that is beyond the threshold of "convenience" in seeking hospital services. The fact that the great majority of such patients do not patronize their nearest hospital would suggest that once the convenience threshold is breached, the comprehensive-care basis of patient choice becomes dominant, even if that lengthens the commute to health care.

70 percent of inpatient visits and 66 percent of outpatient visits were by people who live in the capacity area of the hospital utilized. 19.2 percent of inpatient visits and 22.6 percent of outpatient visits were by people who live within a capacity area but do not utilize the local hospital center. 8.2 percent of inpatient visits and 8.4 percent of outpatient visits were by people who did not reside in a capacity area and chose not to utilize their nearest hospital center. 2.6 percent of inpatient visits and 2.9 percent of outpatient visits were by people who did not live in a capacity area but utilized the nearest hospital center[8].

Another way to look at this is that red and pink dots represent individuals utilizing their "home" hospitals. This accounts for 72.6 percent of inpatient visits and 69 percent of outpatient visits. One might suspect that these percentages would show significant variability if compiled along subsets of hospitals grouped by size or some type of patient service characteristics.

One thing that does stand out in these maps is that, while population centers are readily apparent, there are no clear indications that the structure of transportation (interstate highway corridors, for example) has a significant impact. In many social situations where distance is a factor, maps will show a clear predilection for highway quality. This is not readily apparent here.

Activity Summary by Diagnostic Category

Up to this point, all indicators of patient choice or expectations of patient choice have been based upon patient residence, health care area capacity, health care facility distance, and patient category (inpatient or outpatient). This section summarizes patient record data by major diagnostic category to further explore regional differences in hospital capacity and utilization. Total activity in Iowa's hospitals during the reference year measured 1,633,781 inpatient days and 229,467 outpatient visits. By major diagnosis, the top three diagnostic categories for inpatient and outpatient activity were:

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[7]   In densely populated urban areas, there is often a yellow presence in the population core. This is at least partially a reflection of the proportion of patient referrals that would exist in any area, magnified according to the density of the population.

[8]   It is interesting that among residents of an identified health care area inpatients are more likely to utilize the local hospital than are outpatients. In contrast, among patients that do not reside in an identified health care area outpatients are more likely to patronize the hospital nearest their residence than are inpatients. One might use this as the foundation of a hypothesis that the convenience threshold of patient choice is more pronounced than the comprehensive-service basis for outpatients relative to inpatients.

Inpatient days
- Diseases of the circulatory system (16.6 percent of total inpatient days)
- Diseases of the respiratory system (11.1 percent)
- Diseases of the digestive system (9.2 percent)

Outpatient visits
- Diseases of the digestive system (24.7 percent of total outpatient visits)
- Diseases of the nervous system and sense organs (20.8 percent)
- Symptoms, signs, and ill defined conditions (11.5 percent)

Inpatient and outpatient activity varied slightly from the statewide averages among the low (fewer than 50 hospital beds), mid (50-to-100 hospital beds), and high (more than 100 hospital beds) capacity hospital regions. Table 4 summarizes the top three diagnostic categories for the three groups of regions as defined by capacity.

Among the low-capacity hospital regions, the top three inpatient diagnostic categories accounted for 42.4 percent of total inpatient days. The comparable values for the mid and high-capacity regions were 39.5 and 36.5 percent, respectively. The top three diagnostic categories for outpatient visits accounted for 61.9 percent of low-capacity region totals, 62.9 percent for mid-capacity regions, and 55.2 percent of high-capacity region totals. These declining values by capacity size reflect the greater diversity of services available and utilized in the state's largest hospitals.

Table 4: Top three diagnostic categories as measured by percentage of total inpatient
days and outpatient visits

Low-capacity regions – Inpatient Days	Low-capacity regions – Outpatient Visits
Diseases of the respiratory system (17.2%)	Diseases of the digestive system (29.8%)
Diseases of the circulatory system (14.4%)	Diseases of the nervous system and sense organs (18.2%)
Diseases of the digestive system (10.8%)	Neoplasms (13.9%)
Mid-capacity regions – Inpatient Days	Mid-capacity regions – Outpatient Visits
Diseases of the circulatory system (14.4%)	Diseases of the nervous system and sense organs (27.7%)
Diseases of the respiratory system (13.9%)	Diseases of the digestive system (24.5%)
Diseases of the digestive system (11.2%)	Symptoms, signs, and ill-defined conditions (10.8%)
High-capacity regions – Inpatient Days	High-capacity regions – Outpatient Visits
Diseases of the circulatory system (17.3%)	Diseases of the digestive system (23.7%)
Diseases of the respiratory system (9.8%)	Diseases of the nervous system and sense organs (20.1%)
Injury and poisoning (9.4%)	Symptoms, signs, and ill-defined conditions (11.4%)

Diagnosis-based Choice Relative to Proximity Areas

The maps above look at patient-type commuting on the basis of estimated capacity areas. Another way to look at this issue is from the perspective of diagnosis group commuting based on equidistant proximity areas. Hospitals pursuing specialization strategies are often attempting to draw patients from beyond their immediate areas. The likelihood of these hospitals attracting patients from outside their proximate regions varies by type of patient visit (inpatient and outpatient), by diagnosis, and by local hospital capacity. The following charts illustrate the average success rates of Iowa's hospitals in attracting non-local patients. For each hospital, non-local patients were defined as those with residence zip codes outside that hospital's proximity region. Individual hospital region data were then aggregated into the three capacity size

groupings. Figure 1 shows non-local inpatient days as a percentage of total inpatient days. Figure 2 shows non-local outpatient visits as a percentage of total outpatient visits.

The lists below each figure show the five most prevalent diagnoses for both non-local inpatient visits and non-local outpatient visits to hospitals within each size category. It is apparent that hospitals within different size categories attract different mixes of patients from outside their local areas. This does not mask the observation, however, that in nearly all diagnostic categories for inpatient days and outpatient visits, regions with 100 or more beds have clear comp etitive advantage over smaller regions. The likelihood of attracting patients from outside their proximate regions is relatively similar among the mid-capacity and low-capacity regions.

Figure 1: Average percentage of non-local inpatient days by diagnostic category and regional hospital capacity
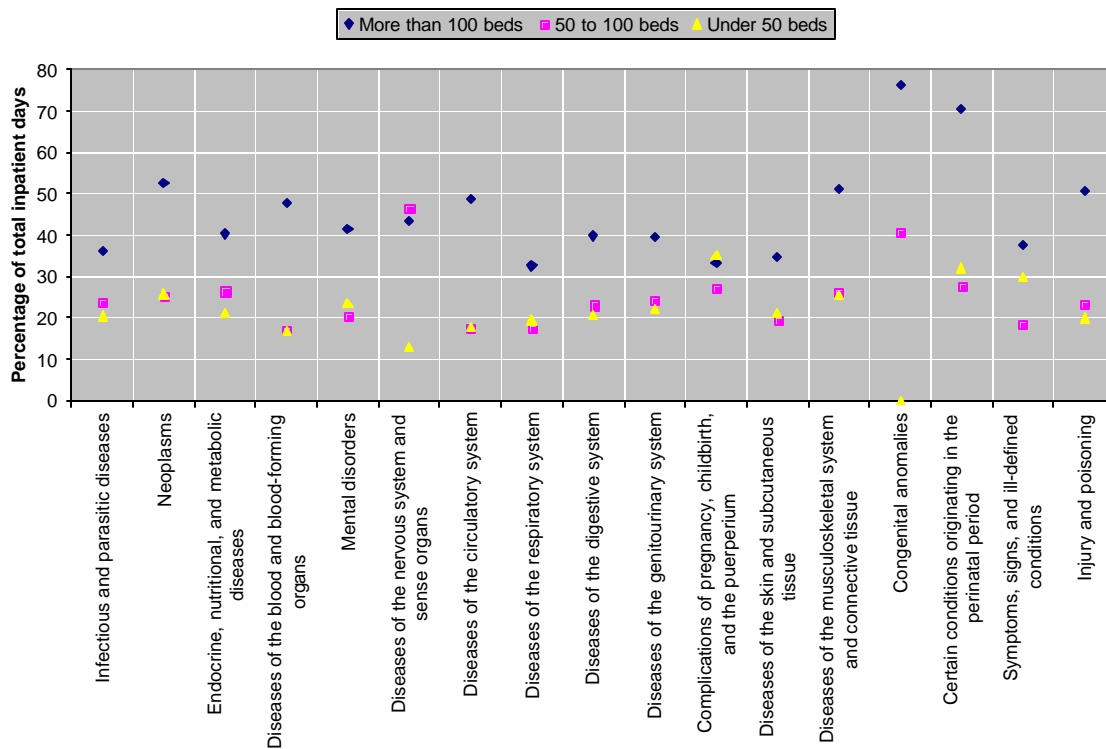
The top 5 non-local inpatient rates for small hospital regions (fewer than 50 beds) were:
- Complications of pregnancy, childbirth, and the puerperium (35.4 percent)
- Certain conditions originating in the perinatal period (32.1 percent)
- Symptoms, signs, and ill-defined conditions (29.8 percent)
- Neoplasms (25.7 percent)
- Diseases of the musculoskeletal system and connective tissue (25.6 percent)

The top 5 non-local inpatient rates for mid-sized hospital regions (50 to 100 beds) were:
- Diseases of the nervous system and sense organs (46.4 percent)
- Congenital anomalies (40.7 percent)
- Certain conditions originating in the perinatal period (27.6 percent)
- Complications of pregnancy, childbirth, and the puerperium (27.1 percent)
- Endocrine, nutritional, and metabolic diseases (26.4 percent)

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The top 5 non-local inpatient rates for large hospital regions (more than 100) were:

- Congenital anomalies (76.2 percent)
- Certain conditions originating in the perinatal period (70.4 percent)
- Neoplasms (52.6 percent)
- Diseases of the musculoskeletal system and connective tissue (51.0 percent)
- Injury and poisoning (50.7 percent)

Figure 2: Average percentage of non-local outpatient visits by diagnostic category and regional hospital capacity
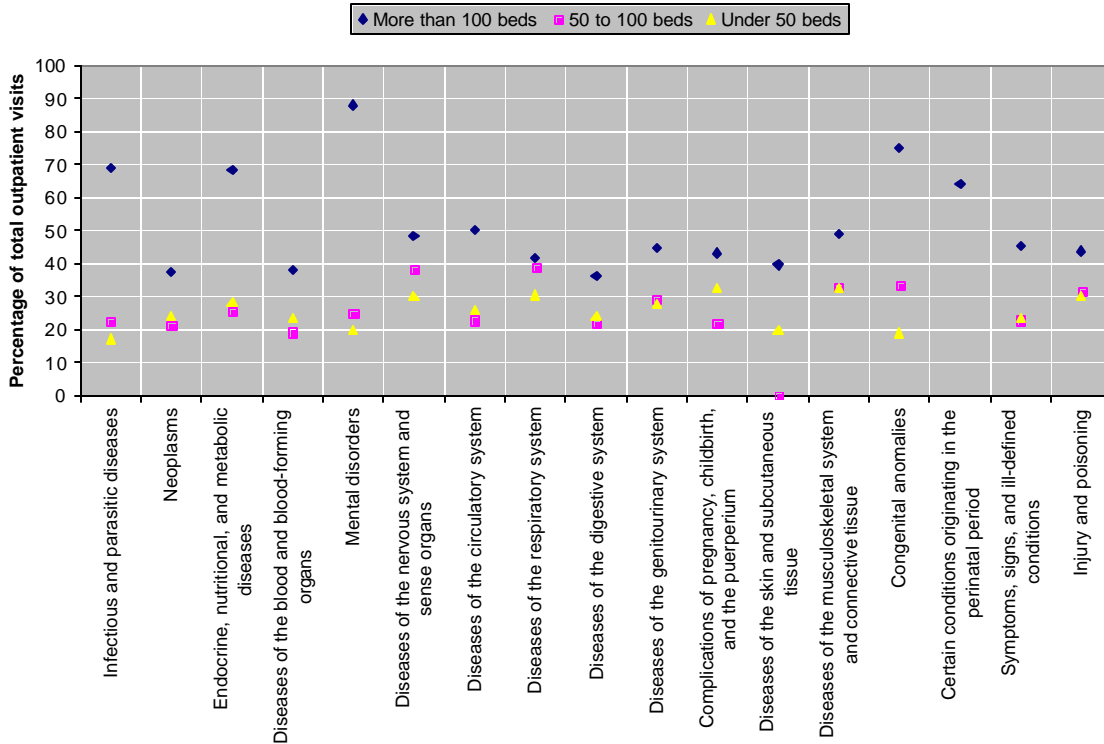
The top 5 non-local outpatient rates for small hospital regions (fewer than 50 beds) were:

- Diseases of the musculoskeletal system and connective tissue (32.7 percent)
- Complications of pregnancy, childbirth, and the puerperium (32.6 percent)
- Diseases of the respiratory system (30.5 percent)
- Injury and poisoning (29.9 percent)
- Diseases of the nervous system and sense organs (29.9 percent)

The top 5 non-local outpatient rates for mid-sized hospital regions (50 to 100 beds) were:

- Diseases of the respiratory system (38.9 percent)
- Diseases of the nervous system and sense organs (38.2 percent)
- Congenital anomalies (33.3 percent)
- Diseases of the musculoskeletal system and connective tissue (32.6 percent)
- Injury and poisoning (31.7 percent)

The top 5 non-local outpatient rates for large hospital regions (more than 100 beds) were:
- Mental disorders (88.0 percent)
- Congenital anomalies (75.2 percent)
- Infectious and parasitic diseases (69.2 percent)
- Endocrine, nutritional, and metabolic diseases (68.5 percent)
- Certain conditions originating in the perinatal period (64.3 percent)

Summary and Conclusion

This effort has shown that a substantial amount of visual information can be generated from commonly available data regarding hospital services if a simple geography is imposed.

Initial insights from this work are the result of nothing more than analyzing population and bed counts on the basis of hospital locations and proximity areas. This showed that, while the distribution of hospital beds in the state is correlated with the distribution of population, there are differences between proximity areas in different population classes. Proximity areas with populations between 12,500 and 25,000 people had fewer beds per capita and lower ratios of both inpatient and outpatient visits per capita than areas with either lower or higher populations. Whether this is due to minimum viable hospital size propping up bed and service numbers in smaller areas or some other factors is beyond the scope of this work, but the result warrants some pursuit.

Expanding the geography, a gravity model was generated using distance and hospital bed counts as variables. This estimated the probability that patients at any spot would patronize a particular hospital. Overlaying these areas on the proximity areas immediately exposes a variety of expected drawing capacities. Some capacity (bed count) areas extend far beyond their corresponding proximity areas. Some appear to be shrunken within their proximity areas. The resulting map provides a preliminary perspective on hospital strength.

Replacing bed counts with inpatient days as the attractive coefficient in the gravity model changes the perspective of areas estimated from capacity to utilization. Capacity is a supply decision made by hospital or public administrators. Utilization is a demand decision made by potential patrons. Comparing the areas generated under these two coefficients provides a simple visual perspective of the spatial strength of supply and demand for hospital services. In addition, the simple calculation of visits divided by annual bed-days provides a simple measure of capacity utilization that is also mapped.

Patients are then categorized by whether they live within an estimated hospital capacity area or they live outside of all identified areas. This distinction is used to calculate proportions of these populations that patronize their local or nearest hospital for both inpatient and outpatient visits. This is a first step in illustrating patron preferences for proximity in health care patronage. It is assumed that potential patients have a positive predisposition towards both convenience (local hospitals) and comprehensiveness (large hospitals). Understanding what types of patients commute for health care is a first step in determining how patients trade off these two predispositions and where the thresholds of these trade-offs might lie.

Finally, out-of-area or nonlocal patronage of hospitals is categorized by type of visit (inpatient or outpatient) and diagnostic category and presented as a percentage of total aggregate hospital patronage for large, medium, and small hospitals. This simple rendering of patient choice provides insight into the diagnostic niches that may be reasonably available to hospitals in the various size groups.

These investigations provide easily accessible visual presentations of readily available information on hospitals and populations served. They illustrate the value of a simple geographic framework in identifying spatial relationships. Further study based on relationships recognize here might result in resource savings, reallocation, and reinvestment in health care staff and facilities for the future.

Appendix 1: Hospitals by hospital number

Iowa Hospital Association 2002 Inpatient Database

Hosp. No.	Hospital Name	City	County	Beds	Class
18	Marshalltown Med./Surg.Center	Marshalltown	Marshall	99	Rural Referral
26	Avera Holy Family Health	Estherville	Emmet	58	Critical Access
34	Sioux Valley Memorial Hospital	Cherokee	Cherokee	67	Rural
59	St. Anthony Regional Hospital	Carroll	Carroll	99	Rural
75	Belmond Medical Center	Belmond	Wright	15	Critical Access
83	Keokuk Area Hospital	Keokuk	Lee	97	Rural
91	Regional Medical Center	Manchester	Delaware	15	Critical Access
125	Washington County Hospital & Clinics	Washington	Washington	25	Critical Access
133	Unity HealthCare	Muscatine	Muscatine	72	Rural
141	Crawford County Memorial Hospital	Denison	Crawford	72	Rural
158	Mercy Medical Center-Sioux City	Sioux City	Woodbury	464	Urban
166	Trinity Regional Medical Center	Fort Dodge	Webster	163	Rural Referral
182	Guthrie County Hospital	Guthrie Center	Guthrie	25	Critical Access
208	Mercy Medical Center-Centerville	Centerville	Appanoose	34	Rural
216	Greene County Medical Center	Jefferson	Greene	25	Critical Access
232	Veterans Memorial Hospital	Waukon	Allamakee	25	Critical Access
240	Iowa Lutheran Hospital	Des Moines	Polk	465	Urban
265	Boone County Hospital	Boone	Boone	57	Rural
273	Mercy Medical Center-New Hampton	New Hampton	Chickasaw	25	Critical Access
281	Alegent Health Mercy Hospital	Council Bluffs	Pottawattamie	260	Urban
299	Mercy Iowa City	Iowa City	Johnson	218	Urban
307	Mary Greeley Medical Center	Ames	Story	200	Rural Referral
315	Myrtue Memorial Hospital	Harlan	Shelby	52	Rural
323	Skiff Medical Center	Newton	Jasper	68	Rural
331	Genesis Medical Center	Davenport	Scott	482	Urban
349	Ellsworth Municipal Hospital	Iowa Falls	Hardin	30	Rural
356	Grundy County Memorial Hospital	Grundy Center	Grundy	25	Critical Access
364	Franklin General Hospital	Hampton	Franklin	25	Critical Access
372	Floyd County Memorial Hospital	Charles City	Floyd	25	Critical Access
380	Covenant Medical Center	Waterloo	Black Hawk	302	Urban
398	Cass County Memorial Hospital	Atlantic	Cass	71	Rural
406	Sartori Memorial Hospital, Inc.	Cedar Falls	Black Hawk	83	Urban
414	Alegent Health Mercy Hospital	Corning	Adams	22	Critical Access
430	Clarinda Regional Health Center	Clarinda	Page	30	Rural
448	Pella Regional Health Center	Pella	Marion	47	Rural
455	St. Luke's Hospital	Cedar Rapids	Linn	400	Urban
463	Wright Medical Center	Clarion	Wright	25	Critical Access
471	Jennie Edmundson Hospital	Council Bluffs	Pottawattamie	236	Urban

489	Ringgold County Hospital	Mount Ayr	Ringgold	40	Rural
497	Clarke County Hospital	Osceola	Clarke	25	Critical Access
505	Mahaska Health Partnership	Oskaloosa	Mahaska	77	Rural
513	Merrill Pioneer Community Hospital	Rock Rapids	Lyon	25	Critical Access
521	Madison County Memorial Hospital	Winterset	Madison	25	Critical Access
539	Mercy Medical Center-Clinton	Clinton	Clinton	163	Rural Referral
547	Van Buren County Hospital	Keosauqua	Van Buren	25	Critical Access
554	Decatur County Hospital	Leon	Decatur	25	Critical Access
562	Jackson County Public Hospital	Maquoketa	Jackson	25	Critical Access
570	Great River Medical Center	West Burlington	Des Moines	148	Rural Referral
588	Univ. of Iowa Hospitals and Clinics	Iowa City	Johnson	813	Urban
604	Davis County Hospital	Bloomfield	Davis	25	Critical Access
612	Lucas County Health Center	Chariton	Lucas	25	Critical Access
620	Dewitt Community Hospital	Dewitt	Clinton	13	Critical Access
638	Central Community Hospital	Elkader	Clayton	25	Critical Access
646	Mercy Medical Center-North Iowa	Mason City	Cerro Gordo	350	Rural Referral
653	Alegent Hlth Comm. Mem. Hosp.	Missouri Valley	Harrison	25	Critical Access
661	Buena Vista Regional Medical Center	Storm Lake	Buena Vista	54	Rural
687	Regional Health Services of Howard Co.	Cresco	Howard	25	Critical Access
695	Mercy Medical Center-Dubuque	Dubuque	Dubuque	382	Urban
703	Adair County Memorial Hospital	Greenfield	Adair	25	Critical Access
729	Stewart Memorial Comm. Hospital	Lake City	Calhoun	49	Rural
737	Marengo Memorial Hospital	Marengo	Iowa	25	Critical Access
745	Orange City Health System	Orange City	Sioux	30	Rural
752	Dallas County Hospital	Perry	Dallas	25	Critical Access
760	Hamilton Hospital	Webster City	Hamilton	40	Rural
778	Monroe County Hospital	Albia	Monroe	25	Critical Access
794	Mercy Medical Center	Cedar Rapids	Linn	350	Urban
810	Winneshiek County Memorial Hospital	Decorah	Winneshiek	75	Rural
821	Iowa Methodist Ambulatory Center	Des Moines	Polk		
828	Iowa Methodist Medical Center	Des Moines	Polk	674	Urban
831	Mercy Ambulatory Center	Des Moines	Polk		
834	Mercy Capitol	Des Moines	Polk	226	Urban
836	Mercy Medical Center-Des Moines	Des Moines	Polk	638	Urban
851	Eldora Regional Medical Center	Eldora	Hardin	18	Rural
869	People's Memorial Hospital	Independence	Buchanan	25	Critical Access
885	Story County Medical Center	Nevada	Story	25	Critical Access
893	Ottumwa Regional Health Center	Ottumwa	Wapello	221	Rural Referral
901	Montgomery Co. Memorial Hospital	Red Oak	Montgomery	40	Rural
919	Loring Hospital	Sac City	Sac	33	Rural
927	Shenandoah Medical Center	Shenandoah	Page	44	Rural
935	Virginia Gay Hospital	Vinton	Benton	29	Rural
943	Waverly Municipal Hospital	Waverly	Bremer	25	Critical Access
950	Hancock County Memorial Hospital	Britt	Hancock	25	Critical Access
976	Guttenberg Municipal Hospital	Guttenberg	Clayton	25	Critical Access
984	Audubon County Memorial Hospital	Audubon	Audubon	25	Critical Access
992	Grape Community Hospital	Hamburg	Fremont	25	Critical Access
1016	Broadlawns Medical Center	Des Moines	Polk	200	Urban

1024	Metropolitan Medical Center	Des Moines	Polk	211	Urban
1032	Jones Regional Medical Center	Anamosa	Jones	25	Critical Access
1040	Trinity Medical Center North Campus	Davenport	Scott	150	Urban
1065	Henry County Health Center	Mount Pleasant	Henry	50	Rural
1073	Burgess Health Center	Onawa	Monona	48	Rural
1081	Mitchell Co. Regional Health Center	Osage	Mitchell	25	Critical Access
1099	Sioux Center Community Hos/Health Center	Sioux Center	Sioux	21	Critical Access
1107	Allen Health System	Waterloo	Black Hawk	204	Urban
1115	Manning Regional Healthcare Center	Manning	Carroll	17	Critical Access
1123	Spencer Hospital	Spencer	Clay	99	Rural
1131	Wayne County Hospital	Corydon	Wayne	28	Rural
1149	Knoxville Area Community Hospital	Knoxville	Marion	59	Rural
1156	Jefferson County Hospital	Fairfield	Jefferson	67	Rural
1164	Southwest Iowa Regional Medical Center	Creston	Union	80	Rural
1172	The Finley Hospital	Dubuque	Dubuque	126	Urban
1180	Palo Alto County Health System	Emmetsburg	Palo Alto	32	Rural
1206	Keokuk County Health Center	Sigourney	Keokuk	25	Critical Access
1222	Fort Madison Community Hospital	Fort Madison	Lee	50	Rural
1248	Lakes Regional Healthcare	Spirit Lake	Dickinson	49	Rural
1263	Northwest Iowa Health Center	Sheldon	O'Brien	28	Rural
1297	Palmer Lutheran Health Center, Inc.	West Union	Fayette	25	Critical Access
1305	Osceola Community Hospital, Inc.	Sibley	Osceola	32	Critical Access
1313	Horn Memorial Hospital	Ida Grove	Ida	42	Rural
1347	Hawarden Community Hospital	Hawarden	Sioux	25	Critical Access
1354	Mercy Hospital of Franciscan Sisters	Oelwein	Fayette	25	Critical Access
1388	Community Memorial Hospital	Sumner	Bremer	25	Critical Access
1404	Floyd Valley Hospital	LeMars	Plymouth	44	Rural
1420	Pocahontas Community Hospital	Pocahontas	Pocahontas	25	Critical Access
1438	Kossuth Regional Health Center	Algona	Kossuth	40	Rural
1453	Hegg Memorial Health Center	Rock Valley	Sioux	28	Critical Access
1461	St. Luke's Health System, Inc.	Sioux City	Woodbury	364	Urban
1479	Grinnell Regional Medical Center	Grinnell	Poweshiek	81	Rural
1511	Baum-Harmon Mercy Hospital	Primghar	O'Brien	14	Critical Access
1529	Humboldt County Memorial Hospital	Humboldt	Humboldt	21	Critical Access

Appendix 2: Hospital service territory modeling system

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The Hospital Service Territory Modeling System (HSTMS) estimates the geographic extent and population size of health care service territories surrounding 105 hospital cities in Iowa.

Theoretical Framework

The HSTMS application is based on Huff's Probabilistic Model (1963), a gravity-based model which measures the influence, or attractive pull, of retail shopping areas. Gravity models assume that larger places have a more attractive pull on consumers than smaller places, but this pull decays over distance. In a traditional Huff's model, the probability that an individual in place i will shop in the subject place s is determined by the size of s, the number n and size of competing destinations j, and the distance from i to each competing destination. The probability P is expressed as:

$$P = \frac{(\text{size of } s / (\text{distance from } i \text{ to } s)\,^\wedge\,2)}{\sum_{j=1}^{n} (\text{size of } j / (\text{distance from } i \text{ to } j)\,^\wedge\,2)}$$

In the HSTMS application, the estimated probability value P represents the likelihood that patients living in a particular location will choose the subject city when seeking medical care. A probability value is calculated for each place in a pool of potential patient locations surrounding the subject city. Using these probabilities, the spatial extent of a hospital's service territory can be estimated. Once delineated, the service territory may be assessed using measures such as land area, population size, median household income, and other variables.

Procedures

Several parameters are set prior to estimating service territories for Iowa's hospital locations. These parameters include: (1) an initial search radius that defines a potential patient pool and a set of competing destinations for each hospital city; (2) a measure of "size" for the subject city and competing destinations; and (3) a method for measuring distance, and (4) a mathematical function to simulate the decaying effects of size as distance increases.

Selecting the patient pool and competitor pool

Potential patients include residents of any township within a 45-mile radius of the subject location. A discrete set of competing health care destinations is identified for each potential customer location when the probability values are calculated. The pool of competing destinations includes any hospital city within 45 miles of the patient location.

Measuring the size of health care service destinations

This model is place-based rather than hospital-based. Data for communities with multiple hospitals are aggregated to the city level. Data for hospitals in Cedar Falls and Waterloo are also combined because the two cities are in such close proximity. The HSTMS uses two alternative measures for the size of the subject place and its competitors. The first measure is the number of patient beds in all of the city's hospitals. The second measure is the sum of patient days for all visits to hospitals in the subject place during 2002.

<u>Selecting a distance measure</u>

The HSTMS measures the orthogonal distance between patient locations and health care destinations using their latitude and longitude coordinates. This method provides highly accurate approximations of road distance between places.

<u>Selecting a distance decay function</u>

In gravity models, a transformation is usually applied to the distance values to compound the deterring effects of distance on destination choice. Distance squared (distance^2) is a frequently-used transformation, however studies using actual customer origin and destination data have determined the effects of distance vary by type of consumer good. Patient data from the IHA Inpatient Database suggest a distance decay function of 2.5 (distance^2.5) more closely describes the distribution of hospital trips by distance traveled for patients in Iowa.

<u>Estimating and Describing the Trade Area</u>

The HSTMS solves Huff's Equation to obtain a P-value for each customer location in the customer pool. Next, the P values are used as "elevation" observations to interpolate a minimum-curvature probability surface around the subject location. The probability surface represents the likelihood of patients in various locations choosing the subject destination. The probability surface can be simplified into "contours" to delineate a 50% probability region around the subject place. Any township whose population-weighted midpoint falls within the 50 percent probability region for a hospital city is assigned to that hospital city's service territory. Township-level data are then compiled and aggregated to describe population size and other attributes of the service territories.

Software

This application was developed using ESRI's Arc View Version 3.2, and the Arc View Spatial Analyst Extension Version 2.0.

References and Data Sources

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Iowa Hospital Association Inpatient Database, 2002.

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Appendix 3: Hospital region areas, populations, and utilization

| City | Hospital Number(s) | Hosp. Beds | Patient Days | Regions Defined with Respect to Distance and | | | | Capacity Utililization Ratio |
| | | | | Hospital Beds | | Patient Days | | |
				Area	Pop.	Area	Pop.	
Albia	778	25	2,226	181.2	5,848	181.2	5,848	24.4
Algona	1438	40	3,540	429.5	11,296	465.2	11,959	24.2
Ames	307	200	40,858	469.8	70,720	576.8	72,336	56.0
Anamosa	1032	25	777	180.4	9,096	72.0	7,555	8.5
Atlantic	398	71	9,248	645.6	16,506	719.7	17,815	35.7
Audubon	984	25	1,733	217.7	3,845	181.9	3,652	19.0
Belmond	75	15	821	109.4	3,523	73.5	3,136	15.0
Bloomfield	604	25	3,168	172.7	4,685	172.7	4,685	34.7
Boone	265	57	8,468	250.0	19,046	250.0	19,046	40.7
Britt	950	25	1,711	322.4	5,625	250.4	4,422	18.8
Carroll	59	99	8,719	427.4	17,032	391.1	16,821	24.1
Cedar Rapids	455, 794	750	116,701	1,248.4	208,373	1,568.9	219,135	42.6
Centerville	208	34	7,463	351.9	11,973	491.9	14,370	60.1
Chariton	612	25	1,727	290.1	8,231	218.0	7,384	18.9
Charles City	372	25	4,716	264.8	11,909	354.3	12,539	51.7
Cherokee	34	67	3,060	539.9	12,611	360.2	9,936	12.5
Clarinda	430	30	2,978	336.6	9,219	300.8	9,014	27.2
Clarion	463	25	1,662	181.9	4,674	145.1	3,907	18.2
Clinton	539	163	38,060	258.4	36,108	330.2	37,677	64.0
Corning	414	22	2,503	283.9	3,785	319.8	3,954	31.2
Corydon	1131	28	1,829	372.4	4,280	336.5	4,155	17.9
Council Bluffs	281, 471	496	50,426	138.1	70,979	107.5	69,802	27.9
Cresco	687	25	1,444	218.2	6,572	218.2	6,572	15.8
Creston	1164	80	7,804	639.8	13,620	604.3	13,295	26.7
Davenport	331, 1040	632	107,830	522.3	151,800	555.2	153,266	46.7
Decorah	810	75	5,028	593.2	20,424	491.2	18,544	18.4
Denison	141	72	2,326	499.7	13,784	214.6	9,670	8.9
Des Moines	240, 821, 828, 831, 834, 836, 1016, 1024	2,414	330,791	2,641.2	475,528	2,857.4	479,254	37.5
Dew itt	620	13	1,377	84.0	7,599	54.5	6,346	29.0
Dubuque	695, 1172	508	59,049	1,033.2	95,389	1,033.2	95,389	31.8
Eldora	851	18	-	178.2	5,477			-
Elkader	638	25	649	278.8	5,305	136.8	2,921	7.1
Emmetsburg	1180	32	2,270	250.2	5,692	250.2	5,692	19.4
Estherville	26	58	4,670	302.4	9,228	273.8	9,008	22.1
Fairfield	1156	67	4,959	402.3	16,620	292.1	14,949	20.3
Fort Dodge	166	163	28,813	756.9	41,469	973.4	45,364	48.4
Fort Madison	1222	50	11,687	206.6	19,326	206.6	19,326	64.0
Greenfield	703	25	1,814	321.1	5,037	178.1	4,085	19.9
Grinnell	1479	81	11,310	543.7	16,977	677.9	18,742	38.3

Grundy Center	356	25	1,710	179.7	4,467	108.4	3,724	18.7
Guthrie Center	182	25	1,674	308.2	7,037	194.9	5,456	18.3
Guttenberg	976	25	2,138	128.7	3,603	128.7	3,603	23.4
Hamburg	992	25	1,168	121.9	2,193	91.9	1,788	12.8
Hampton	364	25	2,042	249.5	7,316	249.5	7,316	22.4
Harlan	315	52	7,336	403.7	11,145	512.3	12,471	38.7
Hawarden	1347	25	1,099	105.2	3,238	32.8	2,760	12.0
Humboldt	1529	21	2,215	144.5	6,925	144.5	6,925	28.9
Ida Grove	1313	42	5,168	505.2	8,757	612.3	11,016	33.7
Independence	869	25	1,987	107.3	8,751	70.7	7,688	21.8
Iowa City	299, 588	1,031	199,967	1,683.3	142,967	2,136.6	152,637	53.1
Iowa Falls	349	30	3,795	251.4	8,761	322.1	11,057	34.7
Jefferson	216	25	3,508	344.0	8,206	344.0	8,206	38.4
Keokuk	83	97	13,447	115.9	15,979	115.9	15,979	38.0
Keosauqua	547	25	1,733	193.4	2,983	169.1	2,304	19.0
Knoxville	1149	59	3,556	186.0	11,686	150.3	11,175	16.5
Lake City	729	49	5,331	284.4	4,216	284.4	4,216	29.8
LeMars	1404	44	5,647	179.5	11,681	179.5	11,681	35.2
Leon	554	25	1,624	363.9	4,931	303.5	4,442	17.8
Manchester	91	15	3,456	216.9	11,223	326.0	13,564	63.1
Manning	1115	17	1,229	108.6	2,758	72.4	2,128	19.8
Maquoketa	562	25	2,477	181.2	9,691	145.2	9,029	27.1
Marengo	737	25	795	145.6	4,204	72.9	3,497	8.7
Marshalltown	18	99	16,400	539.4	37,816	647.4	40,552	45.4
Mason City	646	350	42,387	1,422.3	70,996	1,559.7	74,142	33.2
Missouri Valley	653	25	2,098	45.8	4,264	45.8	4,264	23.0
Mount Ayr	489	40	2,297	503.2	5,045	431.7	4,733	15.7
Mount Pleasant	1065	50	6,057	291.8	15,905	254.9	14,798	33.2
Muscatine	133	72	10,272	166.1	29,747	166.1	29,747	39.1
Nevada	885	25	1,689	70.8	7,337	34.5	6,934	18.5
New Hampton	273	25	2,311	290.2	8,662	217.6	7,056	25.3
Newton	323	68	7,933	219.5	22,177	219.5	22,177	32.0
Oelwein	1354	25	3,345	182.5	10,739	219.0	11,090	36.7
Onawa	1073	48	7,301	394.7	6,357	502.5	8,480	41.7
Orange City	745	30	6,360	108.0	8,189	180.2	9,606	58.1
Osage	1081	25	2,251	238.6	6,165	173.0	5,638	24.7
Osceola	497	25	2,336	179.2	6,309	179.4	5,995	25.6
Oskaloosa	505	77	3,695	419.8	20,392	282.0	17,029	13.1
Ottumwa	893	221	23,501	624.0	39,150	728.6	40,840	29.1
Pella	448	47	5,202	178.4	13,935	178.4	13,935	30.3
Perry	752	25	1,913	180.4	9,928	143.9	9,588	21.0
Pocahontas	1420	25	1,187	362.5	5,292	145.1	2,713	13.0
Primghar	1511	14	511	144.0	1,858	144.0	1,858	10.0
Red Oak	901	40	9,131	354.7	9,960	424.7	10,395	62.5
Rock Rapids	513	25	1,723	126.2	3,654	90.7	3,219	18.9
Rock Valley	1453	28	2,003	143.2	5,542	71.5	3,927	19.6
Sac City	919	33	3,079	216.1	5,990	216.1	5,990	25.6
Sheldon	1263	28	2,947	179.9	6,889	215.9	8,496	28.8

Shenandoah	927	44	3,592	300.5	9,145	264.8	8,876	22.4
Sibley	1305	32	2,375	262.6	5,800	199.0	4,857	20.3
Sigourney	1206	25	535	251.9	4,879	136.1	3,313	5.9
Sioux Center	1099	21	7,741	71.7	7,313	179.4	8,858	101.0
Sioux City	158, 1461	828	113,809	1,397.3	113,024	1,397.3	113,024	37.7
Spencer	1123	99	10,063	572.9	17,806	642.8	20,827	27.8
Spirit Lake	1248	49	6,371	230.7	13,017	295.5	15,404	35.6
Storm Lake	661	54	6,872	361.1	16,709	469.4	18,352	34.9
Sumner	1388	25	1,516	200.4	5,095	90.8	3,065	16.6
Vinton	935	29	962	139.6	7,222	77.0	6,593	9.1
Washington	125	25	4,004	119.9	8,901	119.9	8,901	43.9
Waterloo-Cedar Falls	380, 406, 1107	589	93,571	1,390.7	152,515	1,848.5	161,361	43.5
Waukon	232	25	2,629	250.6	7,162	250.6	7,162	28.8
Waverly	943	25	3,366	195.6	14,660	158.8	13,669	36.9
Webster City	760	40	6,634	288.2	10,767	288.2	10,767	45.4
West Burlington	570	148	28,192	382.8	42,276	504.5	43,757	52.2
West Union	1297	25	2,750	256.6	8,619	256.6	8,619	30.1
Winterset	521	25	3,553	142.6	6,873	142.6	6,873	38.9
State Summary		11,945	1,633,781				37.5

Appendix 4. Summary of activity by hospital center

Region Name	Beds	Service Territory* Population	Total Activity			Percentage from Within Region		
			Inpatient Days	Inpatient Visits	Outpatient Visits	Inpatient Days	Inpatient Visits	Outpatient Visits
Albia	25	5,848	1,200	397	368	81.1	79.8	67.4
Algona	40	11,296	2,173	632	709	81.6	81.5	80.8
Ames	200	70,720	32,358	7,948	5,267	44.6	46.6	46.8
Anamosa	25	9,096	769	281	208	60.6	59.8	54.8
Atlantic	71	16,506	7,743	1,701	520	70.9	70.0	61.7
Audubon	25	3,845	1,454	383	431	87.4	88.0	85.2
Belmond	15	3,523	286	114	210	63.6	64.9	71.9
Bloomfield	25	4,685	2,534	653	596	66.9	65.7	56.4
Boone	57	19,046	7,742	1,818	1,156	77.1	75.6	71.7
Britt	25	5,625	1,081	340	338	48.9	47.9	50.6
Carroll	99	17,032	7,305	1,863	1,139	67.8	67.1	54.2
Cedar Rapids	750	208,373	90,700	21,277	16,652	78.8	79.7	78.8
Centerville	34	11,973	6,751	1,363	756	83.9	84.5	73.3
Chariton	25	8,231	1,591	525	765	68.7	68.4	53.3
Charles City	25	11,909	4,065	1,095	549	80.6	77.9	68.5
Cherokee	67	12,611	2,683	954	764	72.7	71.3	76.2
Clarinda	30	9,219	2,669	793	630	75.9	72.9	71.6
Clarion	25	4,674	1,517	421	394	58.5	45.4	46.2
Clinton	163	50,265	36,066	6,188	1,895	89.7	86.6	82.2
Corning	22	3,785	1,703	510	549	45.4	42.7	46.8
Corydon	28	4,280	1,717	538	229	51.4	49.3	49.8
Council Bluffs	496	70,979	44,920	9,975	4,618	61.0	58.1	60.8
Cresco	25	6,572	871	300	454	59.7	59.3	66.5
Creston	80	13,620	5,936	1,529	1,264	64.1	71.3	72.1
Davenport	632	169,563	81,674	17,757	9,557	70.1	70.2	66.8
Decorah	75	22,661	3,763	1,134	1,241	68.9	66.0	66.6
Denison	72	13,784	1,715	597	915	63.5	64.3	78.6
Des Moines	2,414	475,528	275,490	59,065	27,854	72.7	75.5	79.2
Dewitt	13	7,599	1,376	395	442	63.4	62.8	50.5
Dubuque	508	115,516	52,058	13,005	6,003	74.0	74.3	74.1
Elkader	25	5,305	562	179	108	64.1	60.9	54.6
Emmetsburg	32	5,692	1,734	659	611	62.6	63.6	62.7
Estherville	58	9,600	3,602	1,072	573	80.3	80.1	54.6
Fairfield	67	16,620	4,950	1,221	879	81.6	79.9	72.4
Fort Dodge	163	41,469	27,231	6,757	4,523	72.3	72.5	70.8
Fort Madison	50	22,767	8,606	2,532	2,123	77.6	75.4	57.9
Greenfield	25	5,037	1,365	419	103	77.9	76.8	74.8
Grinnell	81	16,977	9,671	2,821	903	65.3	64.9	56.7
Grundy Center	25	4,467	1,595	219	82	48.8	56.6	50.0
Guthrie Center	25	7,037	1,646	420	137	65.2	65.2	60.6
Guttenberg	25	4,432	1,393	437	152	58.7	55.8	56.6
Hamburg	25	2,478	1,006	305	412	27.2	29.2	42.7

Hampton	25	7,316	1,204	262	314	69.4	63.0	56.7
Harlan	52	11,145	5,157	1,392	826	75.5	75.4	70.6
Hawarden	25	4,369	651	212	68	68.7	66.5	70.6
Humboldt	21	6,925	1,316	439	475	69.1	68.3	64.8
Ida Grove	42	8,757	3,850	913	497	89.7	88.2	76.1
Independence	25	8,751	1,919	627	456	70.0	67.3	65.4
Iowa City	1,031	142,967	172,021	27,983	32,472	27.6	35.0	35.0
Iowa Falls	30	8,761	3,177	995	605	55.6	57.2	61.7
Jefferson	25	8,206	2,205	575	544	66.3	61.7	69.9
Keokuk	97	27,684	9,428	2,738	1,605	84.2	83.1	76.8
Keosauqua	25	2,983	1,677	585	98	47.3	45.5	28.6
Knoxville	59	11,686	2,973	788	507	78.5	75.1	66.1
Lake City	49	4,216	4,526	1,112	692	38.8	39.3	42.2
LeMars	44	11,681	4,124	1,376	525	70.0	70.5	74.5
Leon	25	4,931	1,055	388	363	53.2	52.6	52.9
Manchester	15	11,223	2,742	828	310	53.9	55.8	47.7
Manning	17	2,758	1,108	313	243	63.6	63.9	63.0
Maquoketa	25	9,691	2,301	673	479	70.3	67.0	63.0
Marengo	25	4,204	186	62	6	57.0	58.1	33.3
Marshalltown	99	37,816	14,142	3,851	3,347	79.5	78.9	71.9
Mason City	350	70,996	35,023	9,744	8,375	56.1	58.9	67.7
Missouri Valley	25	4,264	1,842	555	567	39.9	41.8	40.6
Mount Ayr	40	5,369	1,465	408	502	78.4	75.5	74.7
Mount Pleasant	50	15,905	4,116	1,146	1,720	63.7	63.9	47.6
Muscatine	72	30,553	9,563	2,513	2,247	84.6	82.1	79.2
Nevada	25	7,337	1,383	226	204	58.0	62.4	50.0
New Hampton	25	8,662	1,990	584	409	65.6	62.3	54.3
Newton	68	22,177	6,828	1,927	1,558	79.3	78.3	78.2
Oelwein	25	10,739	2,243	679	448	83.5	83.1	68.3
Onawa	48	7,226	5,872	1,512	661	69.9	66.3	59.2
Orange City	30	8,189	5,789	1,199	735	51.3	59.5	51.4
Osage	25	6,165	1,506	570	411	66.5	64.6	63.7
Osceola	25	6,309	1,897	478	399	76.9	74.3	66.4
Oskaloosa	77	20,392	2,197	706	1,151	72.7	72.4	76.3
Ottumwa	221	39,150	17,465	4,700	4,559	76.8	74.3	71.1
Pella	47	13,935	4,473	1,597	1,219	52.0	50.0	50.5
Perry	25	9,928	1,913	440	459	83.4	80.7	78.6
Pocahontas	25	5,292	1,124	298	373	38.1	38.3	49.3
Primghar	14	1,858	486	148	272	28.0	35.8	37.9
Red Oak	40	9,960	8,932	1,761	735	80.9	79.7	67.8
Rock Rapids	25	3,654	1,182	366	144	62.6	62.0	62.5
Rock Valley	28	5,542	1,063	307	146	85.4	82.1	79.5
Sac City	33	5,990	3,046	838	297	68.2	71.6	66.0
Sheldon	28	6,889	2,659	756	580	75.7	73.4	70.0
Shenandoah	44	9,145	2,645	771	795	74.1	74.7	62.3
Sibley	32	6,302	1,836	421	301	53.3	52.5	55.5
Sigourney	25	4,879	294	52	17	80.3	75.0	64.7
Sioux Center	21	7,313	6,686	833	549	84.5	58.6	57.4

Sioux City	828	150,060	91,452	20,748	8,984	71.6	74.8	75.2
Spencer	99	17,806	7,710	2,257	1,347	65.3	64.6	57.4
Spirit Lake	49	13,302	5,109	1,421	704	71.1	70.4	67.6
Storm Lake	54	16,709	4,581	1,403	1,424	63.5	66.7	69.7
Sumner	25	5,095	843	250	252	63.7	65.2	72.2
Vinton	29	7,222	943	379	850	83.9	82.8	60.1
Washington	25	8,901	3,196	895	1,068	67.6	63.8	61.6
Waterloo	589	152,515	67,741	19,217	16,055	79.5	80.1	80.9
Waukon	25	7,162	1,791	581	396	57.7	57.7	60.4
Waverly	25	14,660	2,093	806	1,279	52.8	52.7	58.6
Webster City	40	10,767	5,831	1,692	815	69.1	68.9	68.3
West Burlington	148	46,658	24,680	6,506	6,023	77.5	77.1	75.8
West Union	25	8,619	1,762	622	428	60.9	59.5	52.8
Winterset	25	6,873	3,538	795	408	76.6	75.5	65.2
State Totals	11,927	2,926,324	1,337,821	309,811	211,377	66.1	68.7	65.4

* Service territory populations were estimated using total inpatient days-based gravity regions.
The state total population for Iowa is based on the 2000 Census.

Appendix 5. Populations based on service capacity (beds) and inpatient and outpatient totals

Region Name	Region Totals						Iowa Portions Only					
	Beds		Inpatient Days		Outpatient Visits		Beds		Inpatient Days		Outpatient Visits	
	Area (sq. miles)	Population	Area (sq. miles)	Population	Area (sq. miles)	Population	Area (sq. miles)	Population	Area (sq. miles)	Population	Area (sq. miles)	Population
Albia	181	5,848	181	5,848	181	5,848	181	5,848	181	5,848	181	5,848
Algona	429	11,296	465	11,959	465	11,959	429	11,296	465	11,959	465	11,959
Ames	470	70,720	577	72,336	650	73,698	470	70,720	577	72,336	650	73,698
Anamosa	180	9,096	72	7,555	72	7,555	180	9,096	72	7,555	72	7,555
Atlantic	646	16,506	720	17,815	464	12,655	646	16,506	720	17,815	464	12,655
Audubon	218	3,845	182	3,652	256	5,031	218	3,845	182	3,652	256	5,031
Belmond	109	3,523	74	3,136	74	3,136	109	3,523	74	3,136	74	3,136
Bloomfield	173	4,685	173	4,685	209	4,990	173	4,685	173	4,685	209	4,990
Boone	250	19,046	250	19,046	213	18,763	250	19,046	250	19,046	213	18,763
Britt	322	5,625	250	4,422	250	4,422	322	5,625	250	4,422	250	4,422
Carroll	427	17,032	391	16,821	391	16,821	427	17,032	391	16,821	391	16,821
Cedar Rapids	1,248	208,373	1,569	219,135	1,429	216,172	1248	208,373	1,569	219,135	1,429	216,172
Centerville	352	11,973	492	14,370	352	11,973	352	11,973	492	14,370	352	11,973
Chariton	290	8,231	218	7,384	362	8,944	290	8,231	218	7,384	362	8,944
Charles City	265	11,909	354	12,539	318	12,326	265	11,909	354	12,539	318	12,326
Cherokee	540	12,611	360	9,936	396	10,781	540	12,611	360	9,936	396	10,781
Clarinda	337	9,219	301	9,014	337	9,219	337	9,219	301	9,014	337	9,219
Clarion	182	4,674	145	3,907	145	3,907	182	4,674	145	3,907	145	3,907
Clinton	513	50,265	724	56,548	391	48,695	258	36,108	330	37,677	212	35,339
Corning	284	3,785	320	3,954	426	4,399	284	3,785	320	3,954	426	4,399
Corydon	372	4,280	337	4,155	289	3,975	372	4,280	337	4,155	289	3,975
Council Bluffs	138	70,979	108	69,802	108	69,802	138	70,979	108	69,802	108	69,802
Cresco	218	6,572	218	6,572	218	6,572	218	6,572	218	6,572	218	6,572
Creston	640	13,620	604	13,295	675	13,837	640	13,620	604	13,295	675	13,837

Davenport	528	169,563	662	175,688	393	163,270	522	151,800	555	153,266	388	145,507
Decorah	665	22,661	563	20,781	665	22,661	593	20,424	491	18,544	593	20,424
Denison	500	13,784	215	9,670	500	13,784	500	13,784	215	9,670	500	13,784
Des Moines	2,641	475,528	2,857	479,254	2,190	460,849	2641	475,528	2,857	479,254	2,190	460,849
Dewitt	84	7,599	54	6,346	84	7,599	84	7,599	54	6,346	84	7,599
Dubuque	1,426	115,516	1,442	115,695	1,248	107,155	1033	95,389	1,033	95,389	997	94,877
Elkader	279	5,305	137	2,921	137	2,921	279	5,305	137	2,921	137	2,921
Emmetsburg	250	5,692	250	5,692	357	7,384	250	5,692	250	5,692	357	7,384
Estherville	339	9,600	310	9,380	274	9,008	302	9,228	274	9,008	274	9,008
Fairfield	402	16,620	292	14,949	296	14,763	402	16,620	292	14,949	296	14,763
Fort Dodge	757	41,469	973	45,364	992	45,464	757	41,469	973	45,364	992	45,464
Fort Madison	316	22,767	316	22,767	316	22,767	207	19,326	207	19,326	207	19,326
Greenfield	321	5,037	178	4,085	142	3,908	321	5,037	178	4,085	142	3,908
Grinnell	544	16,977	678	18,742	434	15,905	544	16,977	678	18,742	434	15,905
Grundy Center	180	4,467	108	3,724	72	3,144	180	4,467	108	3,724	72	3,144
Guthrie Center	308	7,037	195	5,456	195	5,456	308	7,037	195	5,456	195	5,456
Guttenberg	165	4,432	164	4,093	128	3,682	129	3,603	129	3,603	93	3,192
Hamburg	191	2,478	161	2,073	161	2,073	122	2,193	92	1,788	92	1,788
Hampton	250	7,316	250	7,316	182	6,828	250	7,316	250	7,316	182	6,828
Harlan	404	11,145	512	12,471	441	11,334	404	11,145	512	12,471	441	11,334
Hawarden	145	4,369	72	3,011	72	3,011	105	3,238	33	2,760	33	2,760
Humboldt	145	6,925	145	6,925	145	6,925	145	6,925	145	6,925	145	6,925
Ida Grove	505	8,757	612	11,016	396	6,134	505	8,757	612	11,016	396	6,134
Independence	107	8,751	71	7,688	71	7,688	107	8,751	71	7,688	71	7,688
Iowa City	1,683	142,967	2,137	152,637	2,005	150,294	1683	142,967	2,137	152,637	2,005	150,294
Iowa Falls	251	8,761	322	11,057	322	11,057	251	8,761	322	11,057	322	11,057
Jefferson	344	8,206	344	8,206	344	8,206	344	8,206	344	8,206	344	8,206
Keokuk	540	27,684	540	27,684	403	23,884	116	15,979	116	15,979	76	15,259
Keosauqua	193	2,983	169	2,304	136	2,062	193	2,983	169	2,304	136	2,062
Knoxville	186	11,686	150	11,175	150	11,175	186	11,686	150	11,175	150	11,175
Lake City	284	4,216	284	4,216	284	4,216	284	4,216	284	4,216	284	4,216
LeMars	180	11,681	180	11,681	216	12,186	180	11,681	180	11,681	216	12,186

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Leon	364	4,931	304	4,442	339	4,856	364	4,931	304	4,442	339	4,856
Manchester	217	11,223	326	13,564	217	11,223	217	11,223	326	13,564	217	11,223
Manning	109	2,758	72	2,128	144	3,066	109	2,758	72	2,128	144	3,066
Maquoketa	181	9,691	145	9,029	253	11,010	181	9,691	145	9,029	253	11,010
Marengo	146	4,204	73	3,497	0	0	146	4,204	73	3,497	0	0
Marshalltown	539	37,816	647	40,552	820	50,423	539	37,816	647	40,552	820	50,423
Mason City	1,422	70,996	1,560	74,142	1,560	74,142	1422	70,996	1,560	74,142	1,560	74,142
Missouri Valley	46	4,264	46	4,264	100	4,944	46	4,264	46	4,264	100	4,944
Mount Ayr	587	5,369	474	4,896	474	4,896	503	5,045	432	4,733	432	4,733
Mount Pleasant	292	15,905	255	14,798	364	16,945	292	15,905	255	14,798	364	16,945
Muscatine	220	30,553	220	30,553	279	30,951	166	29,747	166	29,747	166	29,747
Nevada	71	7,337	34	6,934	34	6,934	71	7,337	34	6,934	34	6,934
New Hampton	290	8,662	218	7,056	218	7,056	290	8,662	218	7,056	218	7,056
Newton	220	22,177	220	22,177	220	22,177	220	22,177	220	22,177	220	22,177
Oelwein	182	10,739	219	11,090	182	10,739	182	10,739	219	11,090	182	10,739
Onawa	468	7,226	576	9,349	432	6,788	395	6,357	502	8,480	359	5,919
Orange City	108	8,189	180	9,606	180	9,606	108	8,189	180	9,606	180	9,606
Osage	239	6,165	173	5,638	173	5,638	239	6,165	173	5,638	173	5,638
Osceola	179	6,309	179	5,995	215	7,330	179	6,309	179	5,995	215	7,330
Oskaloosa	420	20,392	282	17,029	420	20,392	420	20,392	282	17,029	420	20,392
Ottumwa	624	39,150	729	40,840	790	41,278	624	39,150	729	40,840	790	41,278
Pella	178	13,935	178	13,935	223	15,076	178	13,935	178	13,935	223	15,076
Perry	180	9,928	144	9,588	180	9,928	180	9,928	144	9,588	180	9,928
Pocahontas	363	5,292	145	2,713	253	3,689	363	5,292	145	2,713	253	3,689
Primghar	144	1,858	144	1,858	144	1,858	144	1,858	144	1,858	144	1,858
Red Oak	355	9,960	425	10,395	390	10,194	355	9,960	425	10,395	390	10,194
Rock Rapids	126	3,654	91	3,219	63	3,049	126	3,654	91	3,219	63	3,049
Rock Valley	143	5,542	71	3,927	71	3,927	143	5,542	71	3,927	71	3,927
Sac City	216	5,990	216	5,990	145	4,913	216	5,990	216	5,990	145	4,913
Sheldon	180	6,889	216	8,496	180	6,889	180	6,889	216	8,496	180	6,889
Shenandoah	301	9,145	265	8,876	301	9,145	301	9,145	265	8,876	301	9,145
Sibley	299	6,302	199	4,857	163	4,553	263	5,800	199	4,857	163	4,553

Sigourney	252	4,879	136	3,313	20	2,399	252	4,879	136	3,313	20	2,399
Sioux Center	72	7,313	179	8,858	143	8,240	72	7,313	179	8,858	143	8,240
Sioux City	2,393	150,060	2,481	151,896	2,051	146,444	1397	113,024	1,397	113,024	1,326	112,551
Spencer	573	17,806	643	20,827	536	16,775	573	17,806	643	20,827	536	16,775
Spirit Lake	267	13,302	332	15,689	267	13,302	231	13,017	296	15,404	231	13,017
Storm Lake	361	16,709	469	18,352	577	19,575	361	16,709	469	18,352	577	19,575
Sumner	200	5,095	91	3,065	91	3,065	200	5,095	91	3,065	91	3,065
Vinton	140	7,222	77	6,593	162	8,122	140	7,222	77	6,593	162	8,122
Washington	120	8,901	120	8,901	192	10,227	120	8,901	120	8,901	192	10,227
Waterloo	1,391	152,515	1,849	161,361	1,679	158,917	1391	152,515	1,849	161,361	1,679	158,917
Waukon	251	7,162	251	7,162	251	7,162	251	7,162	251	7,162	251	7,162
Waverly	196	14,660	159	13,669	232	16,345	196	14,660	159	13,669	232	16,345
Webster City	288	10,767	288	10,767	216	10,271	288	10,767	288	10,767	216	10,271
West Burlington	600	46,658	786	51,075	786	51,075	383	42,276	504	43,757	504	43,757
West Union	257	8,619	257	8,619	257	8,619	257	8,619	257	8,619	257	8,619
Winterset	143	6,873	143	6,873	143	6,873	143	6,873	143	6,873	143	6,873

Appendix 6. Area beds, populations, and patients as a percent of state totals

Region Name	Beds Total	Beds State share Percent	Populations for regions defined on the basis of Beds	Inpatient-days	Outpatient visits	Pct. of state population for regions defined by Beds	Inpatient-days	Outpatient visits
Albia	25	0.21	5,848	5,848	5,848	0.20	0.20	0.20
Algona	40	0.34	11,296	11,959	11,959	0.39	0.41	0.41
Ames	200	1.68	70,720	72,336	73,698	2.42	2.47	2.52
Anamosa	25	0.21	9,096	7,555	7,555	0.31	0.26	0.26
Atlantic	71	0.60	16,506	17,815	12,655	0.56	0.61	0.43
Audubon	25	0.21	3,845	3,652	5,031	0.13	0.12	0.17
Belmond	15	0.13	3,523	3,136	3,136	0.12	0.11	0.11
Bloomfield	25	0.21	4,685	4,685	4,990	0.16	0.16	0.17
Boone	57	0.48	19,046	19,046	18,763	0.65	0.65	0.64
Britt	25	0.21	5,625	4,422	4,422	0.19	0.15	0.15
Carroll	99	0.83	17,032	16,821	16,821	0.58	0.57	0.57
Cedar Rapids	750	6.29	208,373	219,135	216,172	7.12	7.49	7.39
Centerville	34	0.29	11,973	14,370	11,973	0.41	0.49	0.41
Chariton	25	0.21	8,231	7,384	8,944	0.28	0.25	0.31
Charles City	25	0.21	11,909	12,539	12,326	0.41	0.43	0.42
Cherokee	67	0.56	12,611	9,936	10,781	0.43	0.34	0.37
Clarinda	30	0.25	9,219	9,014	9,219	0.32	0.31	0.32
Clarion	25	0.21	4,674	3,907	3,907	0.16	0.13	0.13
Clinton	163	1.37	36,108	37,677	35,339	1.23	1.29	1.21
Corning	22	0.18	3,785	3,954	4,399	0.13	0.14	0.15
Corydon	28	0.23	4,280	4,155	3,975	0.15	0.14	0.14
Council Bluffs	496	4.16	70,979	69,802	69,802	2.43	2.39	2.39
Cresco	25	0.21	6,572	6,572	6,572	0.22	0.22	0.22
Creston	80	0.67	13,620	13,295	13,837	0.47	0.45	0.47
Davenport	632	5.30	151,800	153,266	145,507	5.19	5.24	4.97
Decorah	75	0.63	20,424	18,544	20,424	0.70	0.63	0.70
Denison	72	0.60	13,784	9,670	13,784	0.47	0.33	0.47

Des Moines	2414	20.24	475,528	479,254	460,849	16.25	16.38	15.75
Dewitt	13	0.11	7,599	6,346	7,599	0.26	0.22	0.26
Dubuque	508	4.26	95,389	95,389	94,877	3.26	3.26	3.24
Elkader	25	0.21	5,305	2,921	2,921	0.18	0.10	0.10
Emmetsburg	32	0.27	5,692	5,692	7,384	0.19	0.19	0.25
Estherville	58	0.49	9,228	9,008	9,008	0.32	0.31	0.31
Fairfield	67	0.56	16,620	14,949	14,763	0.57	0.51	0.50
Fort Dodge	163	1.37	41,469	45,364	45,464	1.42	1.55	1.55
Fort Madison	50	0.42	19,326	19,326	19,326	0.66	0.66	0.66
Greenfield	25	0.21	5,037	4,085	3,908	0.17	0.14	0.13
Grinnell	81	0.68	16,977	18,742	15,905	0.58	0.64	0.54
Grundy Center	25	0.21	4,467	3,724	3,144	0.15	0.13	0.11
Guthrie Center	25	0.21	7,037	5,456	5,456	0.24	0.19	0.19
Guttenberg	25	0.21	3,603	3,603	3,192	0.12	0.12	0.11
Hamburg	25	0.21	2,193	1,788	1,788	0.07	0.06	0.06
Hampton	25	0.21	7,316	7,316	6,828	0.25	0.25	0.23
Harlan	52	0.44	11,145	12,471	11,334	0.38	0.43	0.39
Hawarden	25	0.21	3,238	2,760	2,760	0.11	0.09	0.09
Humboldt	21	0.18	6,925	6,925	6,925	0.24	0.24	0.24
Ida Grove	42	0.35	8,757	11,016	6,134	0.30	0.38	0.21
Independence	25	0.21	8,751	7,688	7,688	0.30	0.26	0.26
Iowa City	1031	8.64	142,967	152,637	150,294	4.89	5.22	5.14
Iowa Falls	30	0.25	8,761	11,057	11,057	0.30	0.38	0.38
Jefferson	25	0.21	8,206	8,206	8,206	0.28	0.28	0.28
Keokuk	97	0.81	15,979	15,979	15,259	0.55	0.55	0.52
Keosauqua	25	0.21	2,983	2,304	2,062	0.10	0.08	0.07
Knoxville	59	0.49	11,686	11,175	11,175	0.40	0.38	0.38
Lake City	49	0.41	4,216	4,216	4,216	0.14	0.14	0.14
LeMars	44	0.37	11,681	11,681	12,186	0.40	0.40	0.42
Leon	25	0.21	4,931	4,442	4,856	0.17	0.15	0.17
Manchester	15	0.13	11,223	13,564	11,223	0.38	0.46	0.38
Manning	17	0.14	2,758	2,128	3,066	0.09	0.07	0.10

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Maquoketa	25	0.21	9,691	9,029	11,010	0.33	0.31	0.38
Marengo	25	0.21	4,204	3,497	0	0.14	0.12	0.00
Marshalltown	99	0.83	37,816	40,552	50,423	1.29	1.39	1.72
Mason City	350	2.93	70,996	74,142	74,142	2.43	2.53	2.53
Missouri Valley	25	0.21	4,264	4,264	4,944	0.15	0.15	0.17
Mount Ayr	40	0.34	5,045	4,733	4,733	0.17	0.16	0.16
Mount Pleasant	50	0.42	15,905	14,798	16,945	0.54	0.51	0.58
Muscatine	72	0.60	29,747	29,747	29,747	1.02	1.02	1.02
Nevada	25	0.21	7,337	6,934	6,934	0.25	0.24	0.24
New Hampton	25	0.21	8,662	7,056	7,056	0.30	0.24	0.24
Newton	68	0.57	22,177	22,177	22,177	0.76	0.76	0.76
Oelwein	25	0.21	10,739	11,090	10,739	0.37	0.38	0.37
Onawa	48	0.40	6,357	8,480	5,919	0.22	0.29	0.20
Orange City	30	0.25	8,189	9,606	9,606	0.28	0.33	0.33
Osage	25	0.21	6,165	5,638	5,638	0.21	0.19	0.19
Osceola	25	0.21	6,309	5,995	7,330	0.22	0.20	0.25
Oskaloosa	77	0.65	20,392	17,029	20,392	0.70	0.58	0.70
Ottumwa	221	1.85	39,150	40,840	41,278	1.34	1.40	1.41
Pella	47	0.39	13,935	13,935	15,076	0.48	0.48	0.52
Perry	25	0.21	9,928	9,588	9,928	0.34	0.33	0.34
Pocahontas	25	0.21	5,292	2,713	3,689	0.18	0.09	0.13
Primghar	14	0.12	1,858	1,858	1,858	0.06	0.06	0.06
Red Oak	40	0.34	9,960	10,395	10,194	0.34	0.36	0.35
Rock Rapids	25	0.21	3,654	3,219	3,049	0.12	0.11	0.10
Rock Valley	28	0.23	5,542	3,927	3,927	0.19	0.13	0.13
Sac City	33	0.28	5,990	5,990	4,913	0.20	0.20	0.17
Sheldon	28	0.23	6,889	8,496	6,889	0.24	0.29	0.24
Shenandoah	44	0.37	9,145	8,876	9,145	0.31	0.30	0.31
Sibley	32	0.27	5,800	4,857	4,553	0.20	0.17	0.16
Sigourney	25	0.21	4,879	3,313	2,399	0.17	0.11	0.08
Sioux Center	21	0.18	7,313	8,858	8,240	0.25	0.30	0.28
Sioux City	828	6.94	113,024	113,024	112,551	3.86	3.86	3.85

Spencer	99	0.83	17,806	20,827	16,775	0.61	0.71	0.57
Spirit Lake	49	0.41	13,017	15,404	13,017	0.44	0.53	0.44
Storm Lake	54	0.45	16,709	18,352	19,575	0.57	0.63	0.67
Sumner	25	0.21	5,095	3,065	3,065	0.17	0.10	0.10
Vinton	29	0.24	7,222	6,593	8,122	0.25	0.23	0.28
Washington	25	0.21	8,901	8,901	10,227	0.30	0.30	0.35
Waterloo	589	4.94	152,515	161,361	158,917	5.21	5.51	5.43
Waukon	25	0.21	7,162	7,162	7,162	0.24	0.24	0.24
Waverly	25	0.21	14,660	13,669	16,345	0.50	0.47	0.56
Webster City	40	0.34	10,767	10,767	10,271	0.37	0.37	0.35
West Burlington	148	1.24	42,276	43,757	43,757	1.44	1.50	1.50
West Union	25	0.21	8,619	8,619	8,619	0.29	0.29	0.29
Winterset	25	0.21	6,873	6,873	6,873	0.23	0.23	0.23