

# Web Screening of US Nursing Homes by Location and Quality

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## Abstract

*To assist American families that will one day need to find a nursing home for a loved one, NLM is developing a "Web 2.0" interface to important evaluative information about nursing homes in the US. Currently in prototype form, our "Nursing Home Screener" locates homes on a Google Map. It allows nursing home quality, indicated by map icons, to be surveyed in any of four major categories: staffing, fire safety deficiencies, healthcare deficiencies, and quality of care inferred from residents' health. Within each category, options can be tailored to user preferences. Furthermore, home attributes can be used to selectively hide home markers of less interest. The goal is to offer the public a timely, easy to use site for the rapid location and comparison of nursing homes, thus identifying those worth further review or a personal visit.*

## Introduction

Finding a nursing home for oneself or a loved one is a difficult task that will be faced at some point by many. One estimate, for Americans of age 65 in 2005, has 35% receiving some nursing home care in their lifetime [1]. There are 1.3-1.6 million nursing home residents (during 1985-2004) [2]. Since most nursing home stays are for 1 year or less (83% in 1999 [3]), the number of admissions annually is greater, e.g., 3.2 million in 2005 [3]. Consequently, the need for home placement will be of concern to about 1-3 million families each year.

There are many homes to choose from, with over 16,000 nationwide (as found in [4]). In seeking a reasonable placement in a given locale, one can start with recommendations and consult existing published and online resources. This is time-consuming, and often happens under stressful circumstances. Trustworthy, uniform, nationwide sources of information to quickly access home quality and capabilities would be most helpful.

With respect to home quality, all federally-funded nursing homes in the US must meet requirements mandated by the Centers for Medicare and Medicaid Services (CMS) and administered by individual states. This mandate includes a standard quarterly

resident assessment survey that captures a "Minimum Data Set" (MDS). From this are derived quality of care metrics, called MDS Quality Measures (QMs). These are calculated per resident, and then aggregated at the facilities level. An example of a QM would be *the percentage of long-stay residents physically restrained in the last 7 days*. The metrics are thought to reflect the quality of care delivered, not just the demographics of the home's residents.

Other facilities-level data are also collected, such as staffing hours of nurses and aides per resident, number of beds, and home ownership type. CMS also mandates roughly annual state inspections of nursing homes, with detailed reporting of healthcare and fire safety deficiencies. Each specific deficiency is reported with a 4-level severity value and 3-level scope (fraction of residents affected) value.

All this information is publicly available online from CMS, through "Nursing Home Compare" [4][5]. The searchable Web interface presents the data in tabular form (and as a downloadable Access database). It is not ideal as a quick screening tool. Rather, one must drill down through candidate homes to find individual QMs and deficiencies. CMS has traditionally offered no overall home ratings, although it recently announced an intention to develop them.

To facilitate fast screening by location and quality, we are developing an alternative interface to the CMS data, with nursing homes as markers on a Google Map. Geolocated interfaces like this, "mashed up" with data not originally intended to be so displayed, are often called part of the "Web 2.0" paradigm [6]. While there are third-party web sites that use CMS data to rank homes in a list, none to our knowledge show multiple homes on a map as we do.

From the QMs and other CMS data, we derive our own metrics of quality, called here "quality hints" (QHs). These are expressed on a 0-100% scale, 100% being best, with a special code if the datum is missing. During construction of the first prototype, the few-dozen derivations were mostly rather simple, e.g., the QM example mentioned above was turned into a QH mainly by changing its sense to *the percentage of long-stay residents NOT physically restrained in the last 7 days*.

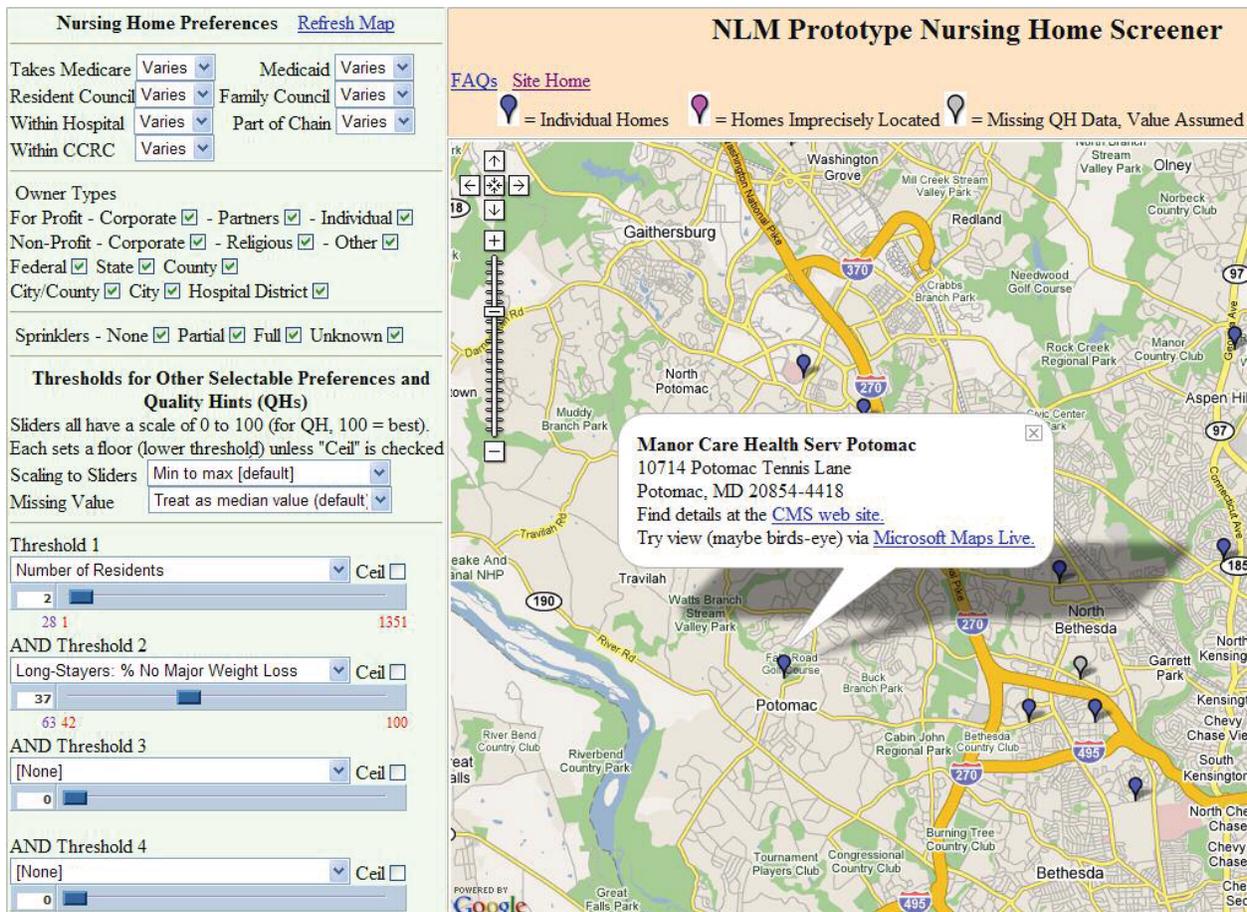


Figure 1. Map page for First Prototype. See the main text and Figure 2 for explanation of sliders.

### First Prototype

The initial concept for the user interface entailed a highly interactive interface in which all controls were at hand and a change was quickly reflected on the map. A private research prototype was so created, with an IIS 6/ASP 2 architecture. To service this site, the downloaded CMS Access database was converted to a custom Access database, which involved data type conversion, statistics calculation, and data pivoting. An inexpensive commercial service provided latitude and longitude coordinates from street addresses.

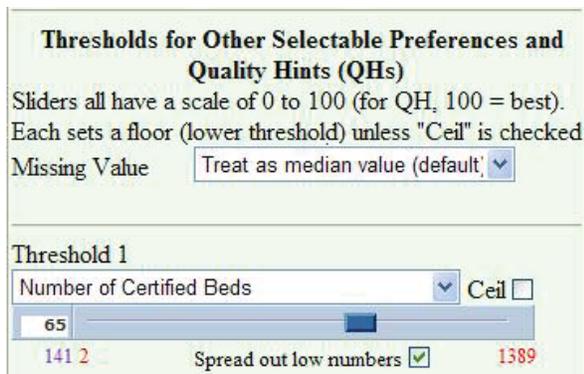
The prototype's home page first allowed a user to enter the desired initial map position (e.g., by town, zip code, or particular nursing home). The map page then appeared (Figure 1), with all nursing home markers within the map boundaries initially shown.

The left column had a rich set of pull-downs, checkboxes, and sliders, to select homes to show. Those nursing home attributes with yes/no values, or those enumerable over a small set of values, were

represented by labeled checkboxes or pull-downs. For preferences or QHs represented by continuous variables, such as number of beds, four initially-unassigned sliders were provided. Above each was a pull-down list of choices (the same set for all sliders), any one of which the user could associate with that slider. Moving a slider's "thumb" adjusted a lower threshold or floor. The marker for a nursing home whose particular QH value was below the threshold would disappear upon next map refresh, triggered by the thumb change.

### First Prototype Limitations and Simplifications

Some of the initial choices available for sliders had a non-uniform value distribution. Consequently, a slider would be insensitive in part of its range and too sensitive elsewhere. The first try at a solution was to provide alternative value-to-slider-position mappings: Figure 1's "Scaling to Sliders" control (left side, mid-way down) offered a half-dozen linear and logarithmic mappings. It was soon recognized that even for an expert, more automatic, constrained, and individualized mapping was needed (Figure 2).



**Figure 2.** Detail of left side map page, revised First Prototype. As before, a slider’s range is mapped to the full nationwide range of database values (here 2 - 1389 certified beds). A slider’s thumb position (expressed as an integer from 0 to 100, here 65) is mapped, with rounding, to a database value (here 141).

Comparing Figures 1 and 2, the earlier global “Scaling to Sliders” control has been dropped; instead, under each slider is a checkbox, “Spread out low numbers”, that sets an alternative logarithmic scaling instead of linear, and whose default state varies depending on the hint chosen.

Ultimately, it was decided to express all the QHs as percentile rankings, guaranteeing a near-uniform distribution. This approach was incorporated into a subsequent round of prototyping discussed next, which also moves away from these overly complex sliders. At the same time, the database underlying the site transitioned to MySQL for scalability.

### Second Prototype

Additional QHs were developed. For instance, the results of state deficiency inspections were turned into numerical scores, inspired by a system created by the State of Florida [7] and later adapted nationwide by Gannett News for a one-time report [8]. The scoring took severity and scope into account.

As more and more of the CMS data was incorporated into the prototype, the list of QHs that one could assign to a slider grew unwieldy, to over 40 items. The research prototype had served its purpose of familiarization with the data. It was time to re-conceptualize the design towards something a layperson could use, while still retaining some flexibility for nursing home placement experts.

On the home page, the user may now specify an interest in either a short-term home stay (typical for

post-hospitalization acute care and rehabilitation, usually paid for by Medicare), or a long-term stay (for chronic diseases, e.g., of the elderly, usually paid for by Medicaid). On the map page (Figure 3), the quality hints are grouped into four categories, each presented as four large tabs.

The previous rather generic home markers are replaced by 5 quality-category icons: gold star, silver star, bronze star, gray dimpled ball, and black mushroom. There are also four icon overlays shown below the Key. For instance, the user can now use the balloon’s “Highlight me” checkbox to put a small checkmark on the icon and also next to home’s name in the lower list of homes. Another overlay, “Must be fixed ASAP or delisted”, (where ASAP is “as soon as possible”) marks troubled homes that are on CMS’s new “Special Focus Facilities” list. Clicking the word “Key” explicates such details, e.g., the gold star “Top” category is a percentile ranking of 90 – 100%.

Each of the large tabs has a default QH associated with it. In all cases the default is a “higher level” QH, i.e., a judicious composite derived from *all* the appropriate QMs. Alternatives to the default can be chosen by clicking on the active tab’s “Explain / Options” link.

For example, the default QH for “Fewer Healthcare Deficiencies” combines results of three annual state inspections, with newer inspections weighted more. But as an alternative, one can choose an average weighting across inspections, or a specific individual inspection. Choosing an alternative can change a home’s percentile ranking, seen as an icon and, in its pop-up balloon, numerically.

As another example, if the user was interested in long-stay possibilities and “Care Quality Inferred from Residents’ Health”, the default QH would be a composite derived from the 14 QMs pertaining to long-stay residents (including the example from our Introduction). The derivation is as follows: after each of the 14 QMs is subtracted from 100%, those values are averaged together. Then the average is percentile ranked against all other homes in the database to form the result. This simple picture is made complicated if a home is missing some QM values. We are still experimenting with various missing-value treatments.

Other nursing home attributes, not taking the form of QHs, can still be used to filter the homes shown; these are now grouped onto a separate page (not shown), found under “Hide Certain Homes”. This page has the controls (largely checkboxes) at the left, with brief explanatory material in the right-hand column instead of the map.

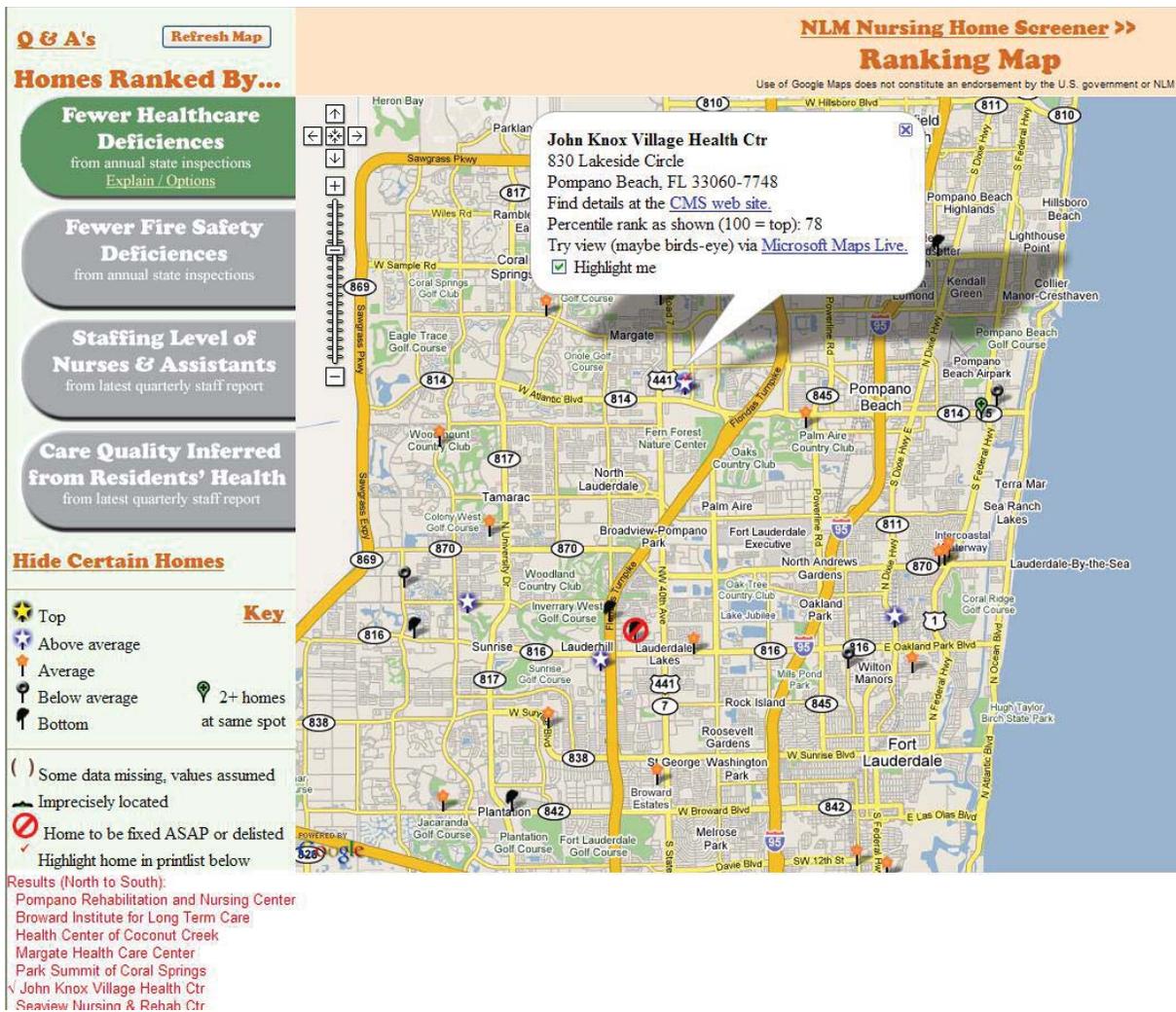


Figure 3. Second Prototype's map page (partial view).

### Projected Users and Their Needs

The initial target audience is seen as the English-fluent cognitively-unimpaired general public with some experience using the web and at least a high-school or equivalent education. Within that, there are two demographic groups of particular salience:

*Middle-aged caregivers*, 40 to 60 years old, typically children of potential residents. The user might be seeking facilities in a broad geographic area, e.g., to relocate a parent near an adult child.

*Older adults*, aged 70 to 85. A user could be a caregiver (often a spouse) or someone anticipating their own nursing home stay. Typically a placement near the current domicile is sought.

Use by healthcare professionals involved in nursing home placement is also envisioned, and in the longer

term the web site may be further enhanced with input and evaluation from such experts.

### Current Work in Progress

The current system, with its simplified map page, is designed to facilitate novice use, while allowing experts some flexibility. Iterative usability testing, design improvement, and implementation are in progress. For instance, links to Microsoft Live Search Maps for bird's eye views (Figure 4) are being made more reliable.

Concurrently, backend C# or Java processes are being developed that work with MySQL and permit monthly CMS data updates to be incorporated into Nursing Home Screener with as little manual effort and time delay as possible. Other anticipated pre-release tasks include tuning for performance under

load, supporting multiple browsers, and providing cross-links to and from other pertinent sites.



**Figure 4.** A typical bird's eye view of a home.

### Some Longer Term Possibilities

Eventually, the system could permit optional retention of user profiles and, in the long run, let individuals and groups (nursing home associations, HMOs, geriatric researchers, consumer and patient-advocacy groups, professional societies, motivated end users, etc.) create, edit, and share profiles. A profile could contain a largely-subjective set of weights, algorithms for deploying them, and descriptive text, allowing customized, personalized health information.

As time goes on, more sources of information (such as those mandated by states, or by data-mining nursing home sites) could be integrated to refine and extend the quality indicators. The site could also link to geriatric research (about quality evaluation, or involving research conducted at specific homes) through NLM's PubMed or other means. It could also incorporate voluntary provider input, such as the availability of hospice care or specialized rehabilitation services.

### Conclusion

This project brings an interactive, map-based interface to an existing nationwide corpus of timely evaluative information about nursing homes. The first prototype demonstrated proof-of-concept, but also exposed limitations in data treatment and overly-complex GUI design. The second prototype addressed the egregious problems, and set the stage for the next round of usability testing. The design seeks to allow nursing homes to be readily located, and indications of their quality to be quickly understood graphically in four major categories. Options within each category offer some responsiveness to user preferences. In addition, homes of less interest can be selectively hidden on the basis of their attributes.

The development of web sites such as ours to speed and ease public evaluation of complex health choices is an important contribution that digital medical libraries can bring to the well-being of the nation.

### Acknowledgements

This research was supported by the Intramural Research Program of the National Institutes of Health (NIH), National Library of Medicine (NLM), and Lister Hill National Center for Biomedical Communications (LHNCBC). Both CMS and NIH are part of the US Dept. of Health and Human Services (HHS). Dr. Pearson, on-site at NLM, is a software developer with Aquilent, Inc. (which has no proprietary interest in the code discussed.) Thanks are due to Rivka Yerushalmi, MSW, who has experience with nursing home placement and is newly participating in this project as field study towards her MLS. She and Sonya Shooshan, Susanne Humphrey, and Dina Demner-Fushman, all of NLM, have suggested improvements to this paper. Other important project participants include Joseph Chow, Kameil Natour, and Wen Cheng.

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