Defining and Monitoring Indwelling Catheter-Related Urinary Tract Infections

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Today’s home care agencies are challenged to meet quality of care standards mandated by accreditation and regulatory bodies and demanded by consumers, and the need to improve patient care through evaluating adverse events in outcome-based quality monitoring reports. This is particularly true in the study of infection control for home care and the requirement to define standards, establish outcome parameters, and ascertain a “best practices” approach. Similarly, it is also important given the gravity and severity of the untoward consequences of urinary tract infections for home care patients (Fiers, 1995; Jarvis, 1996).

The Quality Improvement (QI) Forum with the Arizona Association for Home Care (AAHC) embarked on this task by way of the Urinary Tract Infection (UTI) Benchmarking Project. In this project, UTI definitions related to the use of indwelling catheters were developed and rates were compared across agencies over a 2-year period. The QI Forum chose this topic of study because indwelling urinary catheterization has been common in elderly patients cared for at home and is a procedure associated with documented infection risks. The purpose of this article is to describe the development of infection control parameters in home care and to explain this benchmarking project which includes an analysis of indwelling catheter-related UTI rates among four home care agencies.

Definitions
Infection control monitoring in home care relies on precise definitions and established internal standards. Using mutually understood and accepted definitions is a prerequisite for comparing performance and meaningful statistics among organizations, otherwise known as benchmarking (Hudock et al., 1997). Benchmarking provides meaningful interpretation of the data and the capability for external comparisons to be made, and assists in formulating a best practices approach to care.
One of the first terms used was **nosohusial**, (combining *nosos* [from the Greek for disease] and *hus* [old English root for house]) which did not appear until the early 1990s when infections acquired in the hospital were distinguished from those attributed to home care (Graham, 1994). The Association for Practitioners in Infection Control and Epidemiology (APIC) has since recommended the term “home care-acquired infections” rather than nosohusial or homocomial (Rhinehart & Friedman, 1999). Although normative home care-acquired infection control data are limited, more are being published related to the development of definitional parameters or surveillance methodology for infection control in home care (White & Ragland, 1995; Woomer, Long, Anderson, & Greenberg, 1999). However, the home care industry is lacking in specific data on infection rates, risk factors, and preventive strategies (Friedman & Rhinehart, 2000; CDC, 2001).

Advancing the study of specific home care-acquired infections requires an analysis of the principles of medical epidemiology. A fundamental epidemiological step is to establish a priori definitions, or strict diagnostic criteria (Hennekens, Buring, & Mayrent, 1987). Clear definitions of what constitutes an infection and whether the infection is nosocomial (hospital-acquired) or home care-acquired is a prerequisite for surveillance activities and determining outcome measures (Bennett, 1994).

Differentiating infections based upon etiology is only the first step toward the greater challenge of creating workable definitions and the “rules” for their application in the home. This deviation is largely due to the diversity in the physical and social environment, which is one of only several variables that obscure the interpretation of infection control outcome data in the home. Without a common definition and an estimate for infection, there is no basis for internal evaluation over time or for comparison of one’s performance with what is best in the field (Hudock et al., 1997).

Understandable measurement is another prerequisite for infection control monitoring. Rate or incidence is calculated by dividing the number in a population who have a specific characteristic by the number in the population who are capable of demonstrating that characteristic.

\[
\text{Rate} = \frac{\text{no. cases of disease}}{\text{no. in population at risk}}
\]

If the denominator includes individuals who are not at risk, the resulting measure will underestimate the true rate (Hennekens et al., 1987).

**Background and Literature Review**

There are approximately 2 million (Jarvis, 1996) or 9.8 nosocomial infections per 1,000 patient days (Weinstein, 2000) that occur annually in the United States, resulting in longer hospital stays, higher costs for patients, and a rising concern about quality of care in those facilities. In the 1950s, the Centers for Disease Control (CDC) began to assist acute care hospitals with infection control monitoring by applying medical epidemiology in the hospital setting (CDC, 1981). The study of hospital-acquired infections matured during the 1960s and 1970s, and the CDC has since published very specific recommendations for the surveillance, prevention, and control of infections in a hospital. As a result, a large body of normative data are available for comparing hospitals with each other for device-associated infection rates such as urinary catheter-associated UTI rates (CDC, 1999).

Catheter-related urinary tract infection along with other device-related infections has been studied extensively by the Missouri Alliance for Home Care (MAHC) where an estimated 16% of 5,148 patients monitored in 1 month had infections (CDC, 2001). A recent publication (APIC, 2000) identifies a set of proposed home care definitions of infections for adult patients. Establishing definitions and tracking formulas and benchmark indicators is a major part of this effort and a fundamental element in epidemiology.

Lorenzen and Itkin (1992) were early pioneers in quantifying infection control in the home and worked to define rate and incidence in home care by using two indicators for calculating the incidence of infections. One of their indicators calculated infec-
tion rate by dividing the number of infections by an estimate of patient census (end-of-the-month caseload). The other indicator was defined by dividing the number of infections of the at-risk population by the number of nursing visits to the home. The latter equation was not a measure of incidence or rate because the numerator and denominator represented two distinct populations.

\[
\text{Indicator 1} = \frac{\text{no. infections}}{\text{no. end-of-the-month caseload}}
\]

\[
\text{Indicator 2} = \frac{\text{no. infections}}{\text{no. nursing visits}}
\]

While the effort was well directed, the result was confusing: applying that formula, an agency could decrease infection rate simply by increasing the number of nursing visits.

Later, the essential components of a comprehensive infection control program in home care were described: surveillance, education, consultation, epidemiological investigation, quality improvement activities, and policy and procedure development (Bennett, 1994). Similarly, Deppe (1995) described her efforts to establish an infection control surveillance program at a hospital-affiliated, Medicare-certified home care agency in Illinois. She developed surveillance tools, such as reporting and tracking forms, to identify trends in infections. Using these surveillance tools, she discovered that the highest number of infections were urinary tract infections (UTI) in females. Lacking was the development of a UTI definition and rate-based indicators.

In 1995, Rosenheimer made significant progress toward bringing epidemiology into home care. Under her direction, Marin Home Care developed a surveillance system for urinary tract infections in symptomatic patients with indwelling bladder catheters and bloodstream infection in patients receiving intravenous therapy. The agency’s performance over time was measured using two rate-based indicators, which provided agencies a means to measure their own performance against other agencies. The UTI indicator used patient days as the denominator, which was calculated by multiplying the number of days in each month by the number of patients with indwelling urinary catheters. The numerator was the number of symptomatic UTIs with the resulting rate expressed as a percentage.

\[
\text{Rate} = \frac{\text{no. symptomatic urinary tract infections}}{\text{no. patient days}}
\]

White and Ragland (1995) used a different approach to investigating UTIs in the home setting by examining infections that were procedure-based (number of infections per 100 catheters inserted) and person-based (limited to the first infection for each patient and the number of infections per 10,000 device-days). This study revealed 3.5 UTIs/100 insertions and for those free of infection at the start of home care, a rate of 2.9 UTIs/100 insertions and 20.9 infections per 10,000 catheter days for a sample of 106 patients.

In a later study, Rosenheimer and colleagues (1998) substituted “device days” for patient days and multiplied the resulting percentage by 1,000 to express the indicator as a more conventional rate. Agencies developed their own baseline information for symptomatic UTIs among patients with urinary catheters. This study revealed a mean rate of 4.5 UTIs per 1,000 indwelling device days for four home care agencies in 1 year. Luehm and Fauerbach (1999) proceeded with a similar study and identified a mean overall rate of 2.79 UTIs per 1,000 indwelling device days using the CDC definition of UTIs associated with indwelling catheters.

Similarly, using specific definitions as reported in this article, a mean UTI rate of 3.4 for six agencies using quarterly data over a 2-year period (Woomer, Long, Anderson, & Greenberg, 1999). This study explains the development of the previously published standard performance indicators developed by the AAHC QI and the process used to conduct an in-depth analysis of the performance of four home care agencies. The study provides a fundamental strategy for interpretation of the data that is meaningful to individual agencies and can be used as a basis for comparison, or benchmarking, among other home care agencies to determine if differences by individual agency or by month exist. To do this, monthly UTI rates related to indwelling catheters among four agencies over a two-year period were examined using control charts and repeated measures analysis of variance.

Methodology

In 1996, the AAHC QI Forum established a surveillance system to benchmark incidence rates for UTIs in patients with indwelling catheters. The
**Figure 1.** Performance Standard Indicators for Symptomatic UTIs and Indwelling Catheter Patients.

**Definition:**
Symptomatic UTI: Patients with indwelling catheters (external catheters and suprapubic catheter patients were excluded) who have the following present:
- Physician diagnosis
- Physician institutes appropriate therapy
- One symptom and urine culture of >100,000 organisms

UTI symptoms:
- **F:** Fever, greater than or equal to 100.4°F or chills
- **B:** New or increased burning pain on urination
- **U:** New or increased frequency or urgency
- **S:** New flank or suprapubic pain/tenderness
- **C:** Changes in character of urine (odor or sediment)
- **M:** Worsening mental or functional status (incontinence)

Infections will be attributed to the home, rather than the transferring agency, if symptoms are present 72 hrs from admission. Infections that appear before the time period will be attributed to the transferring agency. If a patient has indwelling catheter changes routinely done in a physician’s office, UTIs present within 72 hrs of the change will not be attributed to home health.

UTIs, which occur at other times during the cycle, will be attributed to home care. Device days are not counted during a patient stay in an acute or extended care setting.

<table>
<thead>
<tr>
<th>Type:</th>
<th>Sentinel event</th>
<th>Structure</th>
<th>Outcome</th>
<th>High Risk</th>
<th>High Volume</th>
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<tbody>
<tr>
<td>Function:</td>
<td>Surveillance, Prevention, and Control of Infection</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Desired Outcome Acceptable Variance:</td>
<td>UTI within acceptable variance range</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rate:</td>
<td>The number of UTIs in indwelling catheter patients per month/no. device days per month ≥ 3,100</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Benchmark:</td>
<td>AAHC Continuous Quality Improvement Forum Participating Agencies (agencies can participate in the project going forward, but cannot participate retroactively simply to meet JCAHO requirements.</td>
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</tbody>
</table>

\[
\text{Incidence rate} = \frac{\text{no. UTIs}}{\text{no. device days}} \times 1,000
\]

<table>
<thead>
<tr>
<th>Study Population:</th>
<th>All patients with indwelling catheters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Source:</td>
<td>Patient medical record, infection reports, lab reports</td>
</tr>
<tr>
<td>Frequency of Data Collection:</td>
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</tr>
<tr>
<td>Frequency of Data Analysis:</td>
<td>Quarterly</td>
</tr>
<tr>
<td>Person(s) Responsible for Data Collection:</td>
<td>Patient care staff, staffing coordinator, performance improvement coordinator</td>
</tr>
<tr>
<td>Individual Responsible for Data Analysis:</td>
<td>Professional services and or nursing supervisor, agency manager</td>
</tr>
<tr>
<td>Dimension:</td>
<td>Safety and Effectiveness</td>
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<tr>
<td>Indicator Type Descriptions:</td>
<td>Sentinel Event: All occurrences warrant investigation</td>
</tr>
<tr>
<td></td>
<td>Rate-based: Further assessment occurs if rate shows a significant trend</td>
</tr>
<tr>
<td></td>
<td>Structure: Inputs into care such as resources, equipment, staffing</td>
</tr>
<tr>
<td></td>
<td>Process: Functions conducted by practitioners, including assessments, planning, and treatment.</td>
</tr>
<tr>
<td></td>
<td>Outcome: Includes complications, adverse events, and results of care/service.</td>
</tr>
<tr>
<td></td>
<td>Problem-prone: Indicators with greater incidence of undesirable outcomes.</td>
</tr>
<tr>
<td></td>
<td>High Risk: Considerable consequences are anticipated should the indicator not be met.</td>
</tr>
<tr>
<td></td>
<td>High Volume: Diagnoses with increased volume or cost.</td>
</tr>
</tbody>
</table>

Reproduced by permission of the National Association for Home Care. Figure 1 (Performance Standard Indicators for Symptomatic UTIs and Indwelling Catheter Patients), from "Benchmarking in Home Health Care: A Collaborative Approach," by N. Woomer, C. O. Long, C. Anderson, and E. A. Greenberg, from CARING magazine, Vol. 18, No. 11 (November 1999). Not for further reproduction.
first step was to establish a case definition of UTI and develop appropriate data collection instruments. The subsequent steps were to establish agency participation rules and methods for data aggregation, analysis, and benchmarking.

**Case Definition and Incidence of Urinary Tract Infections**

The QI Forum developed specific diagnostic criteria for a home care-acquired UTI. Although others have currently established definitions for UTIs in patients with indwelling catheters (MAHC, 1997; Rhinehart & Friedman, 1999), this information was unavailable at the time of the study. Therefore, the QI Forum worked diligently to establish the appropriate criteria and discussed each issue and recommendation that surfaced until a consensus was reached. After an extensive literature review, mutually agreed-upon definitions were developed and incorporated into a Performance Standard Indicator (see Figure 1). These indicators created a reference for all agency participants as part of the UTI Benchmarking Project.

To validate the QI Forum’s work in this area, the regional APIC group reviewed the criteria and recommended the calculation of the incidence of UTIs at a rate per 1,000, the more conventional expression, rather than per 100, as noted in prior studies. APIC recommended including two signs and symptoms of a UTI, which is typical of infection control monitoring in long-term care facilities.

To increase the likelihood that all infections were reported, participating agencies were encouraged to request that independent laboratories submit monthly summaries of all cultures and sensitivities performed for their agency. The monthly report permitted a reliability check that reassured agencies that all participants were striving to report all urinary tract infections as required by the standard indicators. The report also prompted agencies to educate staff members who had neglected to report an infection.

**Agency Participation and Data Collection**

The AAHC encouraged member agencies to participate in the UTI Benchmarking Project by promoting it in the association newsletter and via a presentation by the QI Forum at various association meetings. Start-up packets were assembled and distributed by the QI Forum to all agencies expressing an interest. The packets contained a project summary, the Performance Standard Indicator, and copies of all tracking and reporting forms. Arizona home care agencies were interested in participating in the project; agencies were simultaneously meeting a Joint Commission (JCAHO) requirement to track infections. At its peak, 16 agencies collaborated in the benchmarking project; however, participation waned as agencies passed their Joint Commission surveys. Others participated, but submitted data sporadically. Ultimately, six agencies consistently participated in the project over a 2.5 year period. Of those, four agencies provided monthly UTI rates.

Agencies were assigned alphabetic codes to ensure confidentiality. Each month, agency quality-improvement staff collected the UTI information and summarized it on a standardized data reporting form. Completed forms were delivered to the UTI Benchmarking Project leader responsible for entering the data into summary tables and spreadsheets. Results were reported at quarterly QI Forum meetings, allowing for comparison and stimulating lively discussion. As data accumulated, collaborators studied it intently with the hope of establishing the “norm” as well as the best practice preventing UTIs from indwelling catheters. The descriptive findings, control charts, and analysis of variance (ANOVA) data are reported for the four agencies.

**Results**

This study produced several qualitative and quantitative findings. Overall, home care agency quality managers were able to develop a consensus definition for catheter-related UTIs in the home, providing criteria in which to measure and report findings. In addition, the method for reporting the results, or the UTI rate, was verified and executed uniformly throughout the duration of the UTI Benchmarking Project.

Control charts were constructed from the calculated means and standard deviations for the four agencies that routinely and consistently reported monthly UTI rates over the 2-year period, resulting in 24 data points per agency (Figures 2, 3, 4, and 5). The number of UTIs (numerator) and the number of device days (denominator) computed the proportion nonconforming using the number of UTIs per 1,000 device days.

In none of the control charts were there causes for further investigation as noted by the pattern or incidence of data points that breached the upper control limits (UCLs) or lower control limits (LCLs). However, it was noted that the data points for Agencies A and C centered around the mean.
Control charts identify the mean and upper and lower control limits (UCLs and LCLs), established by three standard deviations above or below the mean, known as sigmas. Typically, control charts assist in determining variations from the mean and to observe the effects of any process or intervention that would affect an outcome. Data points that fall outside of the limits which demonstrate increasing or decreasing patterns in the data points, or those that “hug” around the central line (or mean) signal some change and generally require an investigation (Kelley, 1999).

raising the possibility that variability within the process had decreased.

UTI incidence rates varied considerably over time within agencies and in comparison with each other. The means for the four agencies ranged from 2.78 to 8.08 with a grand mean of 4.4. However, the wide range of means raised the question as to whether the differences were related to the agency or the month. Because control charts do not provide a basis of comparison among agencies—due to the fact that they are only reflective of individual agency performance—another type of analysis was used. An analysis of variance (ANOVA) was performed using a between subjects/repeated measures design with the agency as the “between subjects” factor and month as the repeated factor to determine if there was a difference between agencies over time. The effect of agency was statistically significant, $F(3, 23) = 3.48$, $p = .05$ and the effect of month was not, $F(3, 23) = 1.38$ (see Table 1).

Pairwise comparisons of agencies were conducted to ascertain whether agencies differed from each other with respect to the UTI rates. These comparisons revealed no statistically significant differences. Consequently, a reverse Helmert contrast was performed to determine if there were any differences in agency F, with the highest mean, in comparison to the other three agencies. With an alpha of .05, agency F was noted to be different from the rest $F(1, 69) = 10.08$, $p = .005$.

**Table 1. Analysis of Variance for Agency Effect on UTI Rates**

<table>
<thead>
<tr>
<th>Source</th>
<th>MS</th>
<th>df</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agency</td>
<td>146.35</td>
<td>3</td>
<td>3.48*</td>
</tr>
<tr>
<td>Month</td>
<td>58.31</td>
<td>23</td>
<td>1.38</td>
</tr>
<tr>
<td>Month x Agency</td>
<td>42.11</td>
<td>69</td>
<td></td>
</tr>
</tbody>
</table>

*p < .05.

**Impact on Practice**

Home care and infection control practitioners are progressing tremendously in the uncharted territory of home care-acquired infections. Achieving consensus on infection definitions from empirical findings, epidemiological fundamentals, and current standards of process continues to be a need. As the field of infection control in the home matures, whereby protocols for measurement are established and definitions for home care-acquired infections are refined, quality managers and agency administrators are challenged to develop strategies for measurement within and comparison among other home care agencies.

**Definitions**

This research supported a continuing momentum for the future study of infection control in the home. Although uniform, universally agreed upon definitions for UTIs have not been formally accepted, increased effort in this area and working with APIC and other entities can assist home care agencies with internal agency evaluation and across agency comparison or benchmarking. Pursuing standardization of definitions continues to be a top priority for UTIs and other home care-acquired infections.

**Quality Measurement**

Comparison of outcomes across other home care agencies assists in determining normative criteria for agency performance, and this is particularly important in outcome-based quality monitoring. As previously noted, several studies have reported mean incidence rates, or thresholds, for UTIs in home care patients with indwelling catheters. Although there are no uniformly agreed upon thresholds, individual home care agencies can use those identified in the literature for quality management purposes or by comparing with other agencies, as is currently done by the MAHC Infection Surveillance Project (MAHC, 2001).
use of control charts reinforces the need to monitor agency performance over time based upon the central limit or mean and provides an internal benchmark of performance. By using control charts, agencies can examine patterns of UTIs within their agencies and compare them to other agencies.

As the repeated measures ANOVA indicated, differences in the incidence rates were a function of the agency itself and not time; thus, home care agency mandates to measure quality and improve performance through external benchmarking is a significant initiative. Home care agencies that collaborate for the purpose of quality management can proactively determine key standards to attain and key indicators to measure over time.

Processes of Care
Throughout the implementation of the project, agencies continued to abide by the UTI definition and collected data for the purposes of comparison. As the data were analyzed, the participating agencies posed questions about processes that led to the outcomes and the resultant decreased or increased UTI rates. Issues such as the type and frequency of catheter changes dominated the discussions, establishing a beginning framework for connecting best practices to defined outcomes based upon a mutually agreed upon definition for UTIs related to indwelling catheters. Determining a best practices approach to reduce indwelling catheter-related UTIs is necessary. Home care nurses must define the processes of care in which UTIs can be minimized. Using published research can assist in this effort. Reviewing practice standards, by both APIC and the Wound, Ostomy, and Continence Nurses Society (WOCN), on the management of indwelling catheters should be reviewed (Rhinehart & Friedman, 1999; WOCN, 2001).

By developing and applying standard indicators, executing continuous monitoring, and defining measures for analysis, home care agencies can continue to define and refine infection control practices.

Future Research
Future research in the area of infection control and UTIs for those with indwelling catheters yields several parameters for investigation related to the process of care. When controlling for individual differences of patients, examining the following:

![Figure 2. UTI Control Chart for Agency A; sigma level: 3.](image)

![Figure 3. UTI Control Chart for Agency C; sigma level: 3.](image)

![Figure 4. UTI Control Chart for Agency E; sigma level: 3.](image)

![Figure 5. UTI Control Chart for Agency F; sigma level: 3.](image)
• Types of catheters: The frequency of changing them, and the procedure for preventing infections through education should be considered.
• Risk adjustment is necessary: Particularly because individuals requiring long-term indwelling catheter use may have other comorbidities.
• Confirming thresholds for further investigation and the development of best practice standards can be the ultimate consequence of this research.

While the standards and means for measurement remain in developmental stages, the opportunities over time present with increasing challenges to compare infection control parameters across home care agencies.

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