# Cost, Staffing and Quality Impact of Bedside Electronic Medical Record (EMR) in Nursing Homes

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*Objective:* There is growing political pressure for nursing homes to implement the electronic medical record (EMR) but there is little evidence of its impact on resident care. The purpose of this study was to test the unique and combined contributions of EMR at the bedside and on-site clinical consultation by gerontological expert nurses on cost, staffing, and quality of care in nursing homes.

*Methods:* Eighteen nursing facilities in 3 states participated in a 4-group 24-month comparison: Group 1 implemented bedside EMR, used nurse consultation; Group 2 implemented bedside EMR only; Group 3 used nurse consultation only; Group 4 neither. Intervention sites (Groups 1 and 2) received substantial, partial financial support from CMS to implement EMR. Costs and staffing were measured from Medicaid cost reports, and staff retention from primary data collection; resident outcomes were measured by MDS-based quality indicators and quality measures.

*Results:* Total costs increased in both intervention groups that implemented technology; staffing and staff retention remained constant. Improvement trends were detected in resident outcomes of ADLs, range of motion, and high-risk pressure sores for both intervention groups but not in comparison groups.

*Discussion:* Implementation of bedside EMR is not cost neutral. There were increased total costs for all intervention facilities. These costs were *not* a result of increased direct care staffing or increased staff turnover.

*Conclusions:* Nursing home leaders and policy makers need to be aware of on-going hardware and software costs as well as costs of continual technical support for the EMR and constant staff orientation to use the system. EMR can contribute to the quality of nursing home care and can be enhanced by on-site consultation by nurses with graduate education in nursing and expertise in gerontology. **(J Am Med Dir Assoc 2010; 11: 485–493)**

*Keywords: EMR; costs; quality indicators; nursing homes; advanced practice nurse*

Clinical information systems are designed to assist in the delivery, support, and management of patient care and in administrative and financial matters.[1] Although clinical information systems are not widely used in nursing homes, there is increasing political pressure to implement such systems.[2,3] Bedside electronic medical record (EMR) appears to have potential to improve the efficiency and effectiveness of care in nursing homes, particularly when it helps collect daily measures and outcomes of resident care.[4,5] However, it is not clear if bedside EMR alone is potentially sufficient, or if bedside EMR should be coupled with other on-site interventions to achieve maximum potential effect.

One state's initiative to improve quality in nursing homes demonstrated that on-site clinical consultation by an advanced practice nurse (APN) with clinical expertise in gerontological nursing, coupled with quality indicator feedback reports, contribute to quality care and improved resident outcomes.[6] When on-site clinical consultation was expanded statewide as the Quality Improvement Program for Missouri (QIPMO), improvements were documented in several quality indicators, including pressure ulcers, range of

motion or activities of daily living, and others.[7] Recently, cost analyses revealed improving resident outcomes also has substantial cost savings for nursing homes that use on-site clinical consultation from nurses with graduate education and expertise in gerontological nursing.[8]

This study implemented an intervention designed to evaluate the impact on costs and staffing and test the unique and combined contributions of bedside EMR and on-site clinical consultation by gerontological expert nurses toward improving the care of nursing facility residents. Findings are presented of costs, staffing, and resident outcomes of 18 nursing facilities in 3 states that participated in this evaluation. This represents the first comprehensive evaluation of bedside EMR in nursing homes. Researchers who conducted this evaluation had no commercial interest or relationship with the EMR vendor.

## BACKGROUND

### Bedside EMR Evaluated

This study implemented a bedside EMR developed by Optimus EMR (OEMR, Irvine, CA) that provides access to real-time information for nursing staffs and management in long-term care facilities. The OEMR's goal is to make clinical documentation of care efficient and accurate. The system automates several manual processes, including the preparation of Minimum Data Set (MDS) forms and facilitates accurate reimbursement rates.

The OEMR integrates microchips (iButtons) located on each resident's bracelet and on the caregiver's ID badge, radio frequency (RF), personal data assistants (PDAs), and wireless technology through the company's proprietary software. Data that are collected, either at the point of care with handheld PDAs or entered on a personal computer, automatically populate all appropriate sections in the EMR and the MDS. The OEMR offers a total electronic charting system (including physician orders, medication administration, and treatment records), which streamlines the assessment and documentation process. The system allows for accountability, verification of caregiver activities, bi-directional alerts and messages, and extensive clinical and administrative reports.

### Technology in Health Care

Technology has improved computer charting, care planning, information accessibility, decision making, and perceptions of information security in acute care settings.[9–14] Computerized clinical documentation systems make a measurable improvement in documentation after implementation of an integrated point-of-care system on hospital nursing units.[15] In one study, there was a 13% increase in compliance with Joint Commission accreditation requirements and in another study there was 34% improvement.[10]

Computer use in nursing homes has generally been limited to business applications and management of the federally required MDS.[16,17] There are a few sophisticated systems in limited numbers of nursing homes.[4,5,18,19] These are highly sophisticated computerized systems to manage care, including applications for electronic tracking of resident identification, electronic systems for discharge and transferring residents, and clinical decision support systems used to create opportunities for earlier intervention when resident problems arise.

### Clinical Consultation to Improve Quality

The effectiveness of on-site expert nurse clinical consultation to help nursing homes implement changes to improve care has been demonstrated in a state university–initiated program.[6–8] Other studies have similar results. In a randomly assigned treatment, the use of advanced-practice nurse consultation to implement research-based protocols with nursing home staff resulted in improvement or less decline in incontinence, pressure ulcers, and aggressive behavior.[20] Several studies found that educational programming and resident-centered consultation reduced the use of physical restraints in nursing homes without subsequent increases in staffing or resident injury.[21–26] Similarly, consultation was shown to reduce falls in nursing homes.[27] However, some of these studies and others have demonstrated that follow-through by nursing home staff on the recommendations made during consultation and sustained use of the recommended interventions may be difficult to achieve over time.[28–30]

## METHODS

This evaluation compared 4 groups—2 intervention groups and 2 control groups. Group 1 (n = 4 facilities, 2066 residents) were from Missouri and agreed to implement OEMR and take advantage of the on-site nurse clinical consultation services of QIPMO. Group 2 (n = 4 facilities, 3643 residents) were from 2 other states that implemented OEMR and did *not* have access to on-site services such as QIPMO. Group 3 (n = 5 facilities, 1040 residents) were from Missouri that did *not* implement OEMR but did use QIPMO. Group 4 (n = 5 facilities, 1417 residents) were control facilities from Missouri that did not use OEMR nor QIPMO.

The 4-group design enabled us to evaluate the impact on costs, staffing, and staff retention. It also enabled examining for evidence if the use of bedside EMR can facilitate improved quality of care and subsequent resident outcomes, and if adding on-site clinical consultation can further enhance improvements.

### Sample

A stratified purposive approach was used to recruit facilities from urban and rural areas. Facilities had to be willing to implement bedside EMR. A mix of for-profit, not-for-profit, and governmental facilities were purposefully represented in each group. As an incentive for participation, facilities implementing the OEMR (Groups 1 and 2) received substantial, partial financial support from the Centers for Medicare and Medicaid (CMS) in purchasing the OEMR hardware, software, and ongoing technical support for 2 years of participation in the study. Table 1 displays the characteristics of facilities recruited for the evaluation. Because facilities were continuously enrolled in the study, they have different baseline data dates.

Group 1 (intervention) facilities were solicited from current QIPMO service users in Missouri; 4 facilities (668 total

**Table 1.** *Characteristics of Study Participant Nursing Homes*

| Group | Facility | Bed Size | Ownership | Baseline Quarter |
|---|---|---|---|---|
| 1 Intervention MO-Tech + Quality Improvement Program for Missouri (QIPMO) | 1A | 240 | NFP | Q4 2003 |
| | 1B | 180 | Gov | Q3 2003 |
| | 1C | 98 | FP | Q1 2004 |
| | 1D | 150 | NFP | Q3 2004 |
| | | **668 total beds** | | |
| 2 Intervention Other States- Tech only | 2A | 105 | FP | Q4 2002 |
| | 2B | 218 | FP | Q1 2003 |
| | 2C | 162 | NFP | Q1 2004 |
| | 2D | 150 | NFP | Q2 2004 |
| | | **635 total beds** | | |
| 3 Control MO-QIPMO only | 3A | 123 | Gov | Q4 2003 |
| | 3B | 120 | NFP | Q4 2003 |
| | 3C | 120 | FP | Q4 2003 |
| | 3D | 90 | NFP | Q4 2003 |
| | 3E | 90 | NFP | Q4 2003 |
| | | **543 total beds** | | |
| 4 Control MO-No Tech, No QIPMO | 4A | 180 | FP | Q4 2003 |
| | 4B | 120 | Gov | Q4 2003 |
| | 4C | 154 | Gov | Q4 2003 |
| | 4D | 126 | NFP | Q4 2003 |
| | 4E | 310 | FP | Q4 2003 |
| | | **890 total beds** | | |

beds) were recruited. Four Group 2 (intervention) facilities (635 total beds) were recruited from 2 other states that were users of the OEMR and closely matched to the Group 1 facilities. Because they were not in Missouri, they did not have access to QIPMO services so they acted as a comparison group that only implemented bedside EMR. Five Group 3 facilities (bed count 543), were closely matched to Groups 1 and 2 for ownership, bedside, and location, and were recruited from current QIPMO users in Missouri to act as a comparison group without EMR. Group 4 facilities (bed count 890) were randomly selected from the Missouri MDS data set from those facilities not participating in QIPMO until 5 facilities (bed count 890) were matched as in other groups.

## Research Questions

(1) What is the impact of bedside EMR to collect daily measures of resident care on facility costs, staffing, and staff retention?

(2) Is quality of care provided to nursing home residents improved through the use of bedside EMR alone, on-site clinical consultation alone, or the combined effect of both?

## Intervention Procedures

All intervention facilities required staff to participate in educational training to learn to operate the system. Intervention facilities appointed a project coordinator, who worked closely with OEMR staff during planning and implementation. Group 1 facility staff worked with the QIPMO nurses, who helped staff focus on clinical care and improving care systems that can be facilitated by the OEMR technology. QIPMO nurses provided on-site clinical consultation as

requested by facility staff, but at least every 2 months for the duration of the evaluation. Most facilities used the QIPMO nurses at least monthly during the evaluation and others more often. Group 2 facility staff participated in the standard OEMR educational training required to operate the system, and did *not* have access to QIPMO services.

## Data Collection Procedures

Medicaid cost reports were obtained for cost and staffing analyses. Staff retention data were collected for each facility using staff dates of hire, job code (registered nurse [RN], licensed practical nurse [LPN], aides and orderlies, others) at baseline, year 1, and year 2. Resident outcomes were measured by MDS-derived quality indicators (QIs) and quality measures (QMs). Standardized algorithms[31] that have been extensively used and analyzed[6,32–34] were used to calculate QI scores directly from MDS data for all groups to ensure accurate comparisons.

MDS data captured in the OEMR from each of the participating Group 1 and 2 facilities were used to calculate the QIs. Before data were provided to the research team, all resident identifying information was removed by OEMR staff, and a fictitious unique resident identifier replaced each resident's name or numeric identifier. Groups 3 and 4 QI facility comparisons were made using Missouri MDS data available to the team with the necessary data use agreement from CMS. The study was reviewed and approved by the University's Health Sciences Institutional Review Board before the initiation of the evaluation.

QMs are variations of the MDS QIs, developed by other researchers and reviewed by a CMS-sponsored technical expert panel in 2000.[35] These publicly reported QM scores were downloaded from the public Web site and used in analyses.

## Analysis

Cost and staffing data from Medicaid cost reports were used to describe and compare the 4 study groups at baseline, year 1, and year 2 at study end. Total costs, total direct care costs, staffing costs, direct care staffing hours per resident per day, and staff mix were compared. These comparisons proved insightful in our prior research.[34,36,37] Staff retention was measured with each employee's date of hire, job classification, and full- or part-time status at the same intervals as cost and staffing. Staff satisfaction with the use of technology was measured using focus groups and interviews. Results of the qualitative data analysis are reported elsewhere.[38]

Baseline measures for Groups 1 and 2 were calculated following each facility's implementation (see Table 1 for the dates of baseline), then year 1 post implementation, and year 2 at study end. Baseline dates for QI and QM scores for Groups 3 and 4 were matched to the baseline date of Group 1. A descriptive approach with absolute and relative change scores was used to compare the changes in resident outcomes across groups. Descriptive analysis, rather than statistical testing for significance, is appropriate for this evaluation, owing to the small sample size and nonrandom selection of 3 of the 4 groups.

## RESULTS

### Cost and Staffing

Total costs from Medicaid cost reports were analyzed for individual nursing facilities and for the aggregate of all nursing facilities within each group. In Table 2, total costs indicates all costs per resident day experienced by the nursing facilities. Annual percentage changes in total costs per resident are presented, as well as percentage changes over the study period. Group 1 (bedside EMR + QIPMO) experienced the largest

growth in total costs over the study period with 12.6%; Group 2 facilities (bedside EMR only) experienced the next-largest growth in total costs over the study period with 9.6%. Control facilities in Group 3 (QIPMO only) remained relatively constant, and Group 4 (no EMR, no QIPMO) experienced a slight decrease in total costs over the study period. Similar results were found when only the "direct care costs" associated with providing care to residents in the facility were analyzed.

Table 3 shows staffing costs per resident day and includes only nursing staff—RNs, LPNs, and aides and orderlies. Facilities in Groups 1, 2, and 3 experienced increases in the costs for nursing staff per resident day during the study; Group 4 experienced a slight decline in nursing staff costs. Group 1 experienced the largest rate of increase in nursing staff costs per resident day, and Group 2 experienced the second-highest rate. Even with the increases, Group 1 is still substantially below the average nursing staff cost per resident day in the facilities in Group 2; Group 1 is higher than facilities in Groups 3 and 4. At study end, nursing staff, as a percentage of total costs per resident day, was similar across groups, ranging from 33.5% in Group 3; to 34.9% in Group 4; to 35.0% in Group 1; to 38.6% in Group 2. Among the individual facilities in each of the groups, there were wide variations in changes in the costs of nursing staff costs per resident day. Within each group, at least one facility experienced a decrease in nursing staff costs per resident day during the period of the study.

The use of staff hours per resident enabled the analysis to adjust for the different sizes of the facilities, as well as the differences in wage rates among facilities and across states. As indicated in Table 4, total staff hours per resident per day were stable for each facility, except for one Group 1 facility

**Table 2.** *Total Costs per Resident per Day*

| Costs per Resident | Total Costs | | | | | |
|---|---|---|---|---|---|---|
| | Year 1 | Year 2 | Year 3 | Chg Y1 - Y2 | Chg Y2 – Y3 | Chg Y1 - Y3 |
| 1A | $144.33 | $153.23 | $158.34 | 6.17% | 3.34% | 9.71% |
| 1B | 105.98 | 112.85 | 106.75 | 6.48 | −5.41 | 0.72 |
| 1C | 118.24 | 130.28 | 134.61 | 10.18 | 3.33 | 13.84 |
| 1D | 128.56 | 143.44 | 151.77 | 11.58 | 5.81 | 18.05 |
| Group 1 EMR + QIPMO | $128.29 | $140.12 | $144.40 | 9.22% | 3.06% | 12.56% |
| 2A | 150.56 | 147.73 | 154.08 | −1.88 | 4.30 | 2.34 |
| 2B | 176.60 | 181.94 | 191.66 | 3.03 | 5.34 | 8.53 |
| 2C | 213.60 | 225.64 | 236.98 | 5.64 | 5.02 | 10.95 |
| 2D | 148.78 | 155.43 | 173.02 | 4.46 | 11.32 | 16.29 |
| Group 2 EMR only | $175.31 | $181.28 | $192.20 | 3.41% | 6.02% | 9.63% |
| 3A | 105.98 | 96.83 | 94.51 | −8.64 | −2.39 | −10.83 |
| 3B | 94.16 | 101.87 | 95.83 | 8.19 | −5.93 | 1.78 |
| 3C | 113.93 | 127.99 | 135.38 | 12.34 | 5.78 | 18.82 |
| 3D | 86.47 | 89.88 | 97.85 | 3.94 | 8.87 | 13.16 |
| 3E | 108.45 | 106.41 | 101.31 | −1.88 | −4.79 | −6.58 |
| Group 3 QIPMO only | $103.95 | $105.38 | $103.98 | 1.38% | −1.33% | 0.03% |
| 4A | 105.37 | 99.65 | 99.56 | −5.43 | −0.10 | −5.52 |
| 4B | 86.17 | 92.33 | 91.23 | 7.16 | −1.19 | 5.88 |
| 4C | 97.12 | 86.83 | 81.50 | −10.59 | −6.14 | −16.08 |
| 4D | 105.37 | 99.65 | 99.56 | −5.43 | −0.10 | −5.52 |
| 4E | 98.74 | 101.41 | 106.72 | 2.70 | 5.23 | 8.07 |
| Group 4 no EMR + no QIPMO | $97.50 | $96.43 | $97.29 | −1.09% | 0.89% | −0.21% |

Chg, change; EMR, electronic medical record; QIPMO, Quality Improvement Program for Missouri.

**Table 3.** *Nursing Staffing Costs per Resident per Day*

| Costs per Resident | Staffing Costs | | | | | |
|---|---|---|---|---|---|---|
| | Year 1 | Year 2 | Year 3 | Chg Y1-Y2 | Chg Y2-Y3 | Chg Y1-Y3 |
| 1A | $59.64 | $61.75 | $63.76 | 3.55% | 3.25% | 6.91% |
| 1B | 40.21 | 41.31 | 37.67 | 2.75 | –8.83 | –6.32 |
| 1C | 43.07 | 43.88 | 45.61 | 1.88 | 3.93 | 5.88 |
| 1D | 40.35 | 43.84 | 47.60 | 8.66 | 8.57 | 17.97 |
| Group 1 EMR + QIPMO | $46.02 | $48.69 | $50.55 | 5.80% | 3.81% | 9.83% |
| 2A | 58.21 | 60.62 | 61.33 | 4.15 | 1.17 | 5.36 |
| 2B | 68.17 | 65.60 | 65.75 | –3.77 | 0.23 | –3.55 |
| 2C | 76.99 | 79.98 | 86.70 | 3.89 | 8.41 | 12.62 |
| 2D | 76.63 | 77.34 | 81.51 | 0.92 | 5.40 | 6.37 |
| Group 2 EMR only | $71.00 | $71.34 | $74.21 | 0.48% | 4.03% | 4.53% |
| 3A | 32.01 | 30.19 | 27.18 | –5.69 | –9.95 | –15.08 |
| 3B | 33.03 | 34.31 | 32.49 | 3.88 | –5.30 | –1.62 |
| 3C | 29.30 | 35.77 | 37.14 | 22.08 | 3.81 | 26.74 |
| 3D | 26.12 | 28.45 | 29.88 | 8.93 | 5.05 | 14.42 |
| 3E | 39.43 | 43.66 | 44.23 | 10.72 | 1.33 | 12.19 |
| Group 3 QIPMO only | $34.55 | $35.71 | $34.83 | 3.33% | –2.46% | 0.79% |
| 4A | 30.66 | 28.32 | 26.57 | –7.61 | –6.18 | –13.32 |
| 4B | 34.42 | 36.98 | 36.85 | 7.46 | –0.36 | 7.07 |
| 4C | 38.51 | 34.01 | 31.40 | –11.66 | –7.70 | –18.46 |
| 4D | 39.97 | 41.80 | 46.48 | 4.57 | 11.21 | 16.29 |
| 4E | 34.59 | 34.61 | 37.19 | 0.07 | 7.45 | 7.53 |
| Group 4 no EMR + no QIPMO | $34.62 | $33.75 | $33.96 | –2.51% | 0.61% | –1.92% |

EMR, electronic medical record; QIPMO, Quality Improvement Program for Missouri.

that increased total staff from 2.71 to 3.75 hours per resident per day, accounting for a 38.5% increase in staffing. The hours per resident day were similar and stable for most of the facilities in Groups 1 and 2 with bedside EMR implementation; on average, all staffed more than 3 hours and some more than 4 hours per resident per day. Similarly, most facilities in comparison Groups 3 and 4 had stable staff hours per resident per day during the study; on average, all staffed more than 3 but not as high as 4 hours per resident per day.

## Post Hoc Cost and Acuity Analysis

Post hoc, resident acuity was examined in each of nursing homes to enlighten the cost and outcome analyses. All residents were counted only once and were cared for sometime

**Table 4.** *Total Staff Hours per Resident per Day*

| Hours per Resident | Total Staff Hours | | | | | |
|---|---|---|---|---|---|---|
| | Year 1 | Year 2 | Year 3 | Chg Y1 - Y2 | Chg Y2 - Y3 | Chg Y1 - Y3 |
| 1A | 4.05 | 4.09 | 4.06 | 0.99% | –0.57% | 0.41% |
| 1B | 4.33 | 4.35 | 4.17 | 0.49 | –4.11 | –3.64 |
| 1C | 3.08 | 3.09 | 3.04 | 0.27 | –1.38 | –1.11 |
| 1D | 2.71 | 3.40 | 3.75 | 25.61 | 10.25 | 38.49 |
| Group 1 EMR + QIPMO | 3.38 | 3.71 | 3.83 | 9.89% | 3.24% | 13.45% |
| 2A | 3.95 | 4.13 | 3.98 | 4.52 | –3.60 | 0.76 |
| 2B | 4.66 | 4.47 | 4.25 | –4.04 | –4.89 | –8.73 |
| 2C | 4.49 | 4.59 | 4.78 | 2.20 | 4.16 | 6.46 |
| 2D* | | | | | | |
| Group 2 EMR only | 4.37 | 4.40 | 4.34 | 0.68% | –1.34% | –0.66% |
| 3A | 3.88 | 3.81 | 3.37 | –1.73 | –11.60 | –13.13 |
| 3B | 3.34 | 3.35 | 2.47 | 0.17 | –26.35 | –26.23 |
| 3C | 2.63 | 3.28 | 3.33 | 24.79 | 1.56 | 26.74 |
| 3D | 2.95 | 3.06 | 3.09 | 3.60 | 1.15 | 4.78 |
| 3E | 4.58 | 4.62 | 4.75 | 0.89 | 2.77 | 3.69 |
| Group 3 EMR + QIPMO | 3.74 | 3.71 | 3.53 | –1.78% | –3.51% | –5.23% |
| 4A | 3.04 | 2.95 | 2.86 | –2.94 | –3.09 | –5.94 |
| 4B | 3.57 | 4.06 | 4.01 | 13.89 | –1.43 | 12.26 |
| 4C | 3.50 | 3.50 | 3.24 | –0.01 | –7.45 | –7.46 |
| 4D | 3.63 | 2.80 | 3.90 | –22.73 | 39.24 | 7.60 |
| 4E | 2.86 | 2.93 | 3.20 | 2.65 | 9.10 | 11.99 |
| Group 4 no EMR + no QIPMO | 3.13 | 3.24 | 3.29 | 3.53% | 1.33% | 4.91% |

Chg, change; EMR, electronic medical record; QIPMO, Quality Improvement Program for Missouri.
* Data not available for home 2D because that state does not require reporting staff hours.

during the time interval from the specific facility's baseline date through the third quarter of 2005. Over the evaluation period, there were a total of 8166 residents cared for in the study facilities.

Resource utilization groups (RUGs) are a method of resident acuity measurement and staff utilization in nursing homes.[39] The RUGs III version was used to compare populations; RUGS scores are measured around the number 1 that represents "average" acuity, so smaller numbers reflect lower acuity, higher numbers higher acuity. Groups 1 and 2 had the highest resident acuity (0.94 and 1.10 respectively) and Groups 3 and 4 the lowest (0.90 and 0.86).

Further analysis of the cost reports revealed that the percentage of Medicare residents served *increased* throughout the study in Groups 1 and 2 (6.25% and 9.50% at the end of year 1, then 8.50% and 14.50% at the end of the study), while Group 4 actually *reduced* the number of Medicare residents served from 4.6% to 1.8% by the study end. Acuity differences and fewer Medicare residents may provide some explanation for the lower total and direct care costs in Group 4 as compared with other groups and the higher costs and staffing of Group 2.

### Staff Retention

A retention rate was estimated for each facility using dates of hire for 4 job codes (RN, LPN, aides and orderlies, other), full-time/part-time, and 3 collection dates (baseline, year 1, and year 2). To determine if the rate was increasing or decreasing over time, a regression line was fitted to the data from each facility for each combination.[40] There was no evidence of an increasing or decreasing trend in staff retention over time for any of the groups in this evaluation ($P = .54$). The staffing data were descriptively analyzed as well, examining for trends in individual facilities or groups that would indicate improved staff retention for nurses, nursing assistants, or other staff. These analyses revealed no trends of higher staff retention; potential links to technology or clinical consultation could not be identified.

### Summary of Cost and Staffing Findings

In summary, facilities in Groups 1 and 2 that implemented bedside EMR experienced an increase in total costs per resident per day of $16.11 and $16.89 (12.6% and 9.6%, respectively) during the study. The comparison groups did not experience these increases in total costs. Nursing staffing costs per resident per day increased in Groups 1 and 2 by $4.53 and $3.12 (9.8% and 4.5%), while the nurse staffing costs of comparison Group 3 increased slightly by $0.28 (0.8%) and declined in Group 4 by $0.66 (–1.9%).

Groups 1 and 2 total costs per resident per day were higher ($128.29 and $175.31, respectively) at the beginning of the study than in Groups 3 and 4 ($103.95 and $97.50). The group costs for Groups 1 and 2 did increase throughout the duration of the study, to $144.40 and $192.20, respectively; costs for Groups 3 and 4 remained constant. One facility in Group 1 increased total costs in year 2, but returned to nearly baseline in year 3. Apparently, that facility was able to implement bedside EMR without large increases in total costs.

Although the sample sizes were small, there appeared to be a self-selection effect of facilities with higher costs being willing to embark on the technology challenge. Another explanation is that facilities in the technology groups were serving more acutely ill populations, as suggested by their higher RUG scores and increasing number of Medicare clients over the duration of the study. Lower acuity differences and lower Medicare residents may provide some explanation for the lower total and direct care costs in Group 4, compared with the other groups.

Hours per resident day were similar and stable for most of the facilities in Groups 1 and 2 with technology implementation. Similarly, most facilities in comparison Groups 3 and 4 had stable staff hours per resident per day throughout the study. So, it appears the increased costs for staffing were not from facilities increasing direct care staff hours per resident. Increased staffing costs were likely because of wage adjustments or additional staff not reported in direct or total staff hours worked. Increased total costs were likely because of increased staffing costs, as well as other expenses, such as the addition of technology and inflation of other business expenses.

### Resident Outcomes

Resident outcomes were analyzed to evaluate the effect of technology on outcomes of care using the QI and QM scores (25 QIs and 20 QMs) for each facility at annual intervals for the 24-month duration of the study. Given the small sample sizes, QI and QM scores were analyzed for descriptive trends in absolute and relative change scores across groups. Trends in improvements in several resident outcomes using QIs and QMs can be seen in Table 5. Note, because QIs and QMs are problem-based scores, negative values indicate improvement.

First, decline in late-loss ADLs improved as measured 12 months post implementation in Groups 1 and 2 that implemented bedside EMR. This improvement was sustained, and actually improved more at the 24-month point in Group 2; but the improvement was not sustained in Group 1. The 2 control groups without bedside EMR both showed increasing problems with ADL decline in their residents, as indicated by their increasing (worse) scores.

Similarly, the decline in range of motion QI improved at 12 months in Groups 1 and 2 that implemented bedside EMR. As with ADL decline, Group 1 did not sustain that improvement at the 24-month measurement. These unsustained improvements for Group 1 could be related to some statewide effect, as the control groups without bedside EMR showed increasing problems with both QIs at 12 and 24 months.

Behavioral symptoms improved in both Groups 1 and 2 with bedside EMR and control Group 3 with QIPMO-only services. The improvements in Missouri groups with QIPMO may be interpreted as related to the QIPMO service emphasizing best practices in approaching residents with behavioral symptoms because the control Group 4 without QIPMO got worse.

Symptoms of depression with no treatment had a 12-month improvement in Group 1 with technology and

**Table 5.** *The 12- and 24-Month Relative Improvements in QIs and QMs that Showed Improvement Trends*

| | QI or QM | Group 1 Technology & QIPMO–MO | Group 2 Technology only–other states | Group 3 QIPMO only–MO | Group 4 MO–No tech/no QIPMO |
|---|---|---|---|---|---|
| Quality indicators | Decline in late-loss ADLs | −12%<br>+22% | −18%<br>−44% | +35%<br>+23% | +82%<br>+48% |
| | Decline in range of motion | −1%<br>+45% | −10%<br>−20% | +4%<br>+17% | +41%<br>+75% |
| | Behavioral symptoms | +1%<br>14% | −5%<br>−1% | −11%<br>−15% | +42%<br>+118% |
| | Symptoms of depression no treatment | −6%<br>+7% | +6%<br>+1% | +36%<br>+54% | +77%<br>+63% |
| | No training in bed mobility no ROM | −1%<br>−11% | +71%<br>+44% | +30%<br>+19% | +81%<br>+101% |
| Quality measures | High-risk pressure sores | −53%<br>−3% | −12%<br>−8% | −5%<br>+59% | +435%<br>+105% |
| | Urinary tract infection | −23%<br>−19% | +2%<br>+2% | +22%<br>+46% | +56%<br>+64% |
| | Short-stay delirium | −74%<br>−56% | +200%<br>+150% | −29%<br>−31% | +381%<br>+84% |
| | Physically restrained | −51%<br>−62% | −12%<br>−9% | −23%<br>+61% | −48%<br>−36% |

For each indicator or measure, the top score in each group reflects change at 12 months, while the bottom score reflects change at 24 months. Grey shading highlights improvement trends.

Negative scores indicate *improvement*, as QIs and QMs are problem-based scores.

Descriptive analysis, rather than statistical testing for significance, is appropriate for this evaluation, owing to the small sample size and nonrandom selection of 3 of the 4 groups.

ADLs, activities of daily living; MO, Missouri; ROM, range of motion; QI, quality indicator; QIPMO, Quality Improvement Program for Missouri; QM, quality measure.

QIPMO services, and not in other groups. Similarly, the bed mobility QI had improvements at 12 and 24 months only in this group. This may be interpreted as likely related to the QIPMO service coupled with the bedside EMR.

The QM high-risk pressure sores showed improvements at 12 months for both technology Groups 1 and 2, as well as for Group 3 using only QIPMO services. Groups 1 and 2 sustained the year 1 improvement in year 2, the control groups did not. These improvements may be interpreted as related to bedside EMR, as well as an enhanced effect of QIPMO with EMR.

Similarly, both the urinary tract infection and short-stay delirium QMs improved for Group 1 at 12 and 24 months. This sustained improvement may be interpreted as likely related to the bedside EMR as well as QIPMO. Note improvements in Group 3 for the delirium QM; this may be interpreted as related to QIPMO services.

The use of physical restraints QM improved for all groups in the study at 12 months and most groups at 24 months. The largest improvements can be seen in Group 1. This may be because of the enhanced effect of bedside EMR coupled with QIPMO services. Nationwide emphasis of state and federal survey staff may have influenced reductions, as restraint use is readily observable and measureable.

The QI and QM data were also examined for potential negative impact on resident care from the bedside EMR. No negative trends were detected in the QI or in the QM scores that would indicate an adverse effect on resident care by implementing bedside EMR.

It is important to note that, in addition to these findings, there were large numbers of elements (18 QIs and 16 QMs) that did not show group trends of improvement or that remained relatively constant during the evaluation. The number of indicators with no change was larger than the number with changes.

## DISCUSSION

Based on this study of 18 nursing facilities, it appears that there is beginning evidence of benefits for residents and their outcomes of care from the implementation and use of bedside EMR in nursing homes. In this study, there were trends in improvements in 2 QIs that were seen in groups using bedside EMR but not in other groups: decline in late loss ADLs and decline in range of motion. Additionally, larger and sustained trends in improvements in the pressure sore QM for the technology groups were measured as compared to those without beside EMR.

There were improvements in other QIs and QMs when coupling technology with on-site expert nurse clinical consultation QIPMO service; these include symptoms of depression with no treatment, bed mobility for dependent residents, and urinary tract infection. However, no changes were noted in a large number of indicators, suggesting that improvements possibly attributable to coupling technology with on-site consultation may be specific to certain areas of potential resident improvement.

The OEMR technology prompts and reinforces required care and clinical practice assessment guides that direct nurses and nursing assistants to assess for details of conditions and record care delivered. It is possible that reinforcement from the prompts of the required care and practice guides affected some QIs and QMs that measure resident common conditions. Another possibility that reinforced required care (and subsequently some care outcomes improved) is the report feature of the EMR that can easily tabulate common resident conditions and list if the required care was completed or not. Staff are able to use the report feature to readily view trends in common conditions and care delivery that in traditional paper charting is difficult and time-consuming to compile.

Facilities without technology also showed improvement trends with on-site clinical consultation in some areas. These improvements were not observed in facilities that had neither bedside technology nor on-site clinical consultation. These findings support the effectiveness of on-site consultation by nurses with graduate education and expertise in gerontology, as measured in other QIPMO program evaluations.[6–8]

Costs and staffing are extremely relevant issues to understand as they relate to facilities implementing bedside EMR. Total costs for the 3-year evaluation for the groups of facilities implementing technology increased $16.11 (12.5%) for Group 1 and $16.89 (9.6%) for Group 2, while those for the comparison groups did not. These increases were not a result of increased direct care staffing or turnover. Most likely they are attributable to the cost of the technology, maintaining and supporting the technology, and on-going staff training to use the EMR.

Groups 1 and 2 had higher baseline total costs than comparison Groups 3 and 4. It appears that higher baseline total costs per resident per day in facilities may somehow be related to participating facilities' willingness to undertake technology-based changes. The facilities in both Group 1 (in Missouri) and Group 2 (in other states) that implemented the technology had considerably higher average total costs per resident per day throughout the study than facilities in Groups 3 and 4. However, total staff hours across the 4 groups were very similar (3.83, 4.34, 3.53, and 3.29 on average for the respective groups in year 3; Table 4). There may be some economic feature of facilities willing to undertake implementing a bedside computing system that we were unable to determine.

It appears that implementing technology is not cost neutral—there was an increase in total costs for all facilities in Groups 1 and 2. Although there were increased total costs, these appear to be related to wage adjustments and other cost increases, not increased direct care staffing. This is

a key concern, as facilities face health care worker shortages.[41,42] Nursing home administrators, as well as policy makers, need to be aware of ongoing hardware and software costs, as well as ongoing technology staff support and constant orientation of new direct care staff to the system. These issues must be considered by CMS, EMR vendors, and nursing home owners and staff.

This study has limitations and findings should be interpreted with caution. Results are based on a small convenience sample of 18 nursing homes; therefore, results have a tendency to fluctuate within and between groups. Purposive recruitment was necessary for intervention groups to locate facilities with administrative and corporate staff willing to undertake bedside EMR implementation and related costs. Although substantial, partial funding was provided by CMS to defray a portion of the technology costs. There were implementation and on-going costs to using bedside EMR and that was a challenge for recruiting facilities. Confounding factors such as specific facility efforts to improve care processes or changes to facility admission policies (such as increasing or decreasing Medicare admissions) must all be considered. Despite limitations, this evaluation provides insight into the use of a bedside EMR, how it may improve outcomes and resident care, and the implications on cost, staffing, and staff retention.

Technology seems to hold promise for long-term care. Based on this evaluation of 18 facilities, some improvement in resident outcomes of care seems likely. Improvement in resident outcomes could be enhanced with the addition of on-site consultation by a nurse with graduate nursing education and expertise in gerontology. Some increase in cost related to the technology, staff to support the technology, and continuous staff education to use the technology should be anticipated and planned for as an on-going expense. Direct care staffing is likely to remain constant, as is staff retention. The downside risks of implementing technology appear to be smaller than the upside advantages for improving care.

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