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Development and Pilot Testing of Computerized Order Entry Algorithms for Geriatric Problems in Nursing Homes

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Abstract

Objectives—Computerized order entry algorithms can improve the quality of care; but are rarely used in nursing homes (NHs). We conducted a pilot study to: (1) develop order entry algorithms for 5 common NH problems, and (2) test their acceptance, use, and preliminary impact on quality indicators and resource utilization.

Design—Pre-post, quasi-experimental study.

Setting: 2 Veterans Affairs NHs.

Participants—Randomly selected residents (n=265) with one or more target conditions, and 42 nursing home providers.

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Author Contributions

1. Cathleen S. Colón-Emeric wrote the study protocol, led computerized order entry algorithms development and deployment, interpretation of data, and drafting the manuscript.
2. Kenneth Schmader advised on the study design, participated in computerized order entry algorithms development, interpretation of data, and revising the manuscript.
3. Jack Twersky participated in computerized order entry algorithms development and deployment and revising the manuscript.
4. Maragantha Kuchibhatla completed the data analysis, and assisted in interpretation of data, and revising the manuscript.
5. Sally Kellum participated in computerized order entry algorithms development and deployment, and revising the manuscript.
6. Morris Weinberger advised on the study design, participated in computerized order entry algorithms development, interpretation of data, and revising the manuscript.

Conflict of Interest

1. Cathleen S. Colón-Emeric has no financial or personal conflicts of interest with this study design or report.
2. Kenneth Schmader has no financial or personal conflicts of interest with this study design or report.
3. Jack Twersky has no financial or personal conflicts of interest with this study design or report.
4. Maragantha Kuchibhatla has no financial or personal conflicts of interest with this study design or report.
5. Sally Kellum has no financial or personal conflicts of interest with this study design or report.
6. Morris Weinberger has no financial or personal conflicts of interest with this study design or report.

Intervention—Expert panels developed computerized order entry algorithms based on clinical practice guidelines. Each was displayed on a single screen and included an array of diagnostic and treatment options, and means to communicate with the interdisciplinary team. Medical records were abstracted for the 6 months preceding and following deployment.

Results—Despite positive provider attitudes toward the computerized order entry algorithms, their use was infrequent and varied by condition: Falls (73%), Fever (9%), Pneumonia (8%), UTI (7%), and Osteoporosis (3%). In subjects with falls, we observed trends for improvements in quality measures for the 6/9 measures, including measuring orthostatic blood pressure (17.5% to 30%, p=0.29), reducing neuroleptics (53.8% to 75%, p=0.27), reducing sedative-hypnotics (16.7% to 50.0%, p=0.50), prescription of calcium (22.5% to 32.5%, p=0.45), vitamin D (20.0 to 35.0%, p=0.21), and external hip protectors (25.0 to 47.5%, p=0.06). Little improvement was observed in the other conditions. There was no change in resource utilization.

Conclusion—Computerized order entry algorithms were used infrequently, except for falls. Further study may determine whether their use leads to improved care.

Keywords

nursing homes; information technology; quality of care

BACKGROUND

The Institute of Medicine recommends systematic employment of evidence-based clinical practice guidelines to improve the safety and quality of care.[1] Evidence-based clinical practice guidelines for common problems in nursing home residents are increasingly available,[2-8] but implementing them remains challenging.[9-12] Barriers to implementation include limited provider knowledge of the guidelines, competing patient priorities or expectations, unclear or conflicting guideline recommendations, and lack of system-level infrastructure to support routine guideline use.[13-19] In addition to these barriers, nursing homes face additional challenges including high staff turnover, limited on-site physician presence, and high regulatory requirements which conflict with or distract from guideline implementation.[10, 11, 20]

Computerized order entry algorithms address some of these barriers, and have improved both quality indicators and patient outcomes in acute care settings.[21-23] Computerized order entry algorithms can remind clinicians of recommended steps in care, use default orders to influence treatment choice, and facilitate communication with other interdisciplinary team members through automatic consults or notifications. Nursing homes have been slow to adopt computerized medical records and order entry algorithms[24-27], but several small studies suggest that they are feasible and acceptable to nursing home staff.[28-32] The Veterans Affairs (VA) nursing homes (Community Living Centers) have used computerized order entry for over 10 years, and several large community nursing home chains are investing in this technology. However, the feasibility, acceptability, and impact of computerized order entry algorithms have not been widely evaluated in nursing homes.

We conducted a pilot study to: (1) develop evidence-based computerized order entry algorithms for 5 common nursing home problems, and (2) test their acceptance, use, and preliminary impact on quality indicators and resource utilization in 2 VA nursing homes.

METHODS

This pilot study used a pre-post, quasi-experimental design. The Duke University, and both site VA Institutional Review Boards approved all study procedures.

Setting

Two VA nursing homes, each with over 100 beds, participated. One was academically affiliated and the other was not. Both used a combination of physicians, nurse practitioners, and/or physician assistants (collectively referred to as "providers") to provide long-term, rehabilitation, and palliative care. While staffing varied due to turnover, both homes attempted to maintain 6 providers working in the home at a given time. In addition, 22 medical students, internal medicine/family medicine interns, and geriatric medicine fellows (collectively referred to as "trainees") rotated through the academic nursing home during the study period.

Computerized Order Entry Algorithms

Development and Implementation—We sought both acute and chronic clinical problems that: (1) were prevalent in nursing homes; (2) were supported by evidence-based clinical practice guidelines; (3) involved care that was primarily driven by a single provider (for example, diagnosing and treating osteoporosis is primarily accomplished by the medical provider), or required interdisciplinary coordination (for example, falls prevention requires collaboration and input from multiple disciplines). Falls,[8, 33, 34] fever evaluation,[3, 5] pneumonia,[4, 6, 7, 35, 36] urinary tract infection,[2, 3, 9] and osteoporosis[37, 38] were selected.

A multidisciplinary group of experts was recruited to review the treatment evidence for these problems and determine the guidelines that were most effective, feasible, and cost-effective for the nursing home setting. These were local opinion leaders identified by the study team and local VA administrators, and included geriatricians, a nursing home medical director, an infectious disease specialist, a geriatric nurse specialist, a geriatric nurse practitioner, a registered nurse and a nurse aid who worked in one of the study homes. Attention was given to facilitating interdisciplinary communication through the computerized order entry algorithms; for example, the falls algorithm generated an automatic email alert to the facility pharmacist to request medication review. The expert panel used simple consensus to develop recommendations on the computerized order entry algorithms' content. Based on these recommendations, 5 order algorithms were programmed into the VA computer system. The computerized order entry algorithms were used by members of the panel with test patient records, and refined in several cycles (see Appendix for final algorithms).

To facilitate implementation, 16 providers in both study facilities attended a study kick off session. During these sessions, we reviewed the goals of the project, how the computerized order entry algorithms were developed, and how they might be used to improve the quality of care. We also informed them that, to facilitate their use of these tools, we would post laminated cards on each computer station, and place reminder fliers in their mailboxes each month for the first 5 months. When new providers were hired (n=4 during the study period), study personnel met with them individually to demonstrate the use of the computerized order entry algorithms. Medical students and interns were not individually trained to use the computerized order entry algorithms, but were shown how to use them on an ad hoc basis by the medical director or geriatric medicine fellow during their rotation.

Patient Selection

VA nursing home residents with one or more of the target conditions during the pre and post-implementation periods were identified using queries of the VA computer system followed by chart review as follows:

- Fever: temperature > 38° C
- Pneumonia: Fever plus a new infiltrate on chest imaging, or witnessed aspiration with respiratory symptoms

- Urinary tract infection: Bacteriuria plus antibiotic treatment without other infectious diagnosis
- Fall: Recorded in the Minimum Data Set
- Osteoporosis: Diagnosis recorded on problem list, or dual energy x-ray absorptiometry T score <−2.5, or a low trauma fracture within the last 5 years.

Residents were excluded if they did not remain in the home for at least 48 hours after the onset of an acute condition (e.g., if they were admitted to the hospital), or had advanced-directives that excluded treatment of the condition. If a subject had been included in the pre-study period for osteoporosis, they were not included in the post-study period for osteoporosis. Residents who received guideline-recommended treatment for osteoporosis in the pre-implementation period would also meet these same quality indicator criteria in the post-implementation period, and therefore limit our power to detect a true difference in the proportion of residents receiving guideline-recommended care for osteoporosis between the time periods. A convenience sample of 20 residents with each target condition was sought for each study period based on expected prevalence of the target problems; a resident could contribute to 2 conditions during a study period (e.g., had both a fever and osteoporosis). If a resident had more than 1 of the same event (e.g., 2 falls), only the first was included. When more than 20 residents with the condition were identified, a random number generator was used to select residents; otherwise, all residents with the condition were included.

Quality Indicators

Indicators were selected based on the expert panel recommendations, practice guidelines, or Assessing the Care of Vulnerable Elderly indicators (Table 3).[39, 40] Resource utilization variables included frequency counts of laboratory and radiology tests ordered within 72 hours of onset for acute conditions, or within the 6 month study period for chronic conditions.

Data Collection

Computerized order entry algorithm use was measured by tracking automatic alerts sent to the first author whenever one was accessed. Quality indicators were abstracted from the medical record by a trained nurse or physician for the 6-month periods before and immediately after computerized order entry algorithms deployment. Using a common set of training charts, abstractors were calibrated until they achieved simple agreement on 10 key quality indicators that exceeded 90%.

Providers were surveyed at 1 and 12 months to assess their perceptions of the computerized order entry algorithms using 5-point Likert scales regarding whether they: (1) were evidence-based; (2) were easy to access and use; (3) saved time; and (4) improved the quality of patient care. Providers could write additional comments about their experience with the computerized order entry algorithms.

Analysis

We present descriptive statistics on computerized order entry algorithms use, patient and problem characteristics, quality indicators, and resource utilization variables. Differences in quality indicators between the study periods were tested using Chi square or the appropriate non-parametric test. Because of the exploratory nature of the analysis, no correction for multiple testing was made.

RESULTS

There were potentially 200 residents per time period (target of 20 charts per condition × 5 conditions × 2 study homes). Because some residents were used for more than 1 condition, and because some conditions had fewer than 20 identified events in the time period, the actual sample size is slightly smaller. Overall, review of the records from 265 patients provided information about 276 episodes of care for the target problems. Because differing patient and disease characteristics could account for some of the observed differences in treatment of the target conditions in the 2 study periods, we collected information about these potential confounders. Patients' characteristics were similar during the pre- (N=148) and post- (N=117) periods (table 1); and between the 2 study sites (data not shown). Patients were also similar across the two study periods in terms of the severity of the target conditions (table 2). However, 17% of pre-intervention patients, but no post-intervention patients were selected based on a diagnosis of osteoporosis on their problem list, because most of the long-term care residents with this diagnosis were already included in the pre-implementation group, and were therefore not eligible for inclusion in the post-implementation period. Therefore, the post-intervention patients were more likely to have a remote history of fracture, and less-likely to carry a diagnosis of osteoporosis.

Over the study period, 20 full-time providers and 16 trainees had access to the computerized order entry algorithms. The computerized order entry algorithms were accessed 119 times during the study period by 20 providers. All provider types, including nurse practitioners, physician assistants, trainees (medical interns and geriatric medicine fellows), and attending physicians, used the algorithms. Despite a smaller number of beds, algorithm use was greater at the academic nursing home than the non-academic site (74% vs. 26%). The falls computerized order entry algorithm was the most frequently accessed at both sites (73%), followed by fever (9%), pneumonia (8%), and UTI (7%). The osteoporosis computerized order entry algorithms was rarely accessed (3%), despite linking it to the falls algorithm 3 months after implementation. Both nursing homes experienced substantial, unanticipated provider turnover during the study period (44% in the academic-affiliated home, >100% in the non-academic home). All new staff in the academic home began using the computerized order entry algorithms immediately and no change in utilization was observed, whereas turnover in the non-academic affiliated home led to substantial declines in computerized order entry algorithm use.

Table 3 shows the observed trends in quality indicators for each target condition. Falls quality indicators improved by 10% or more in 6 of 9 quality indicators, whereas little improvement was seen in the other computerized order entry algorithms' indicators. Several declines were observed in osteoporosis quality indicators, likely related to the significantly higher proportion of subjects with osteoporosis documented on their problem list in the pre-implementation period (table 2). Resource utilization for laboratory and radiology tests was not significantly different between the study time periods.

The computerized order entry algorithms were well-received by nursing home providers during training and at the conclusion of the study period. Because only 8 providers had > 3 months of algorithm use at the conclusion of the study and were eligible to complete the survey, we present only their qualitative responses. All 8 providers agreed or strongly agreed that the computerized order entry algorithms were evidence-based, easy to use, improved patient care and saved time. Written comments included that the computerized order entry algorithms helped remind them of all potential guideline-recommended steps, made it faster to complete the orders, facilitated communication with the interdisciplinary team, and were useful in training new staff or learners. Providers valued "being in control" of which orders were selected, which mitigated their distrust of "cookbook medicine."

Several barriers to use were noted. Providers noted that for chronic conditions such as osteoporosis, there was no acute event or "prompt" to remind them to access the computerized order entry algorithm. Acute conditions, such as fever, frequently occurred after hours and orders were given over the phone to the nursing staff, rather than entered directly into the computer by the providers. Providers in the academic affiliated VA reported that the computerized order entry algorithms were difficult to access; although the algorithms themselves were contained on a single screen, space limitations made it necessary to have those screens accessed from a sub-folder, rather than from the main order page. Providers in the non-academically affiliated VA reported that the high provider turnover and under-staffing during the study period resulted in more verbal orders and more emergency room transfers for acute illnesses or falls, limiting the opportunities for computerized order entry algorithm use by nursing home providers.

DISCUSSION

Computerized order entry systems have the potential to improve the quality of care in nursing homes, but few previous studies have evaluated their feasibility or impact. We developed evidence-based computerized order entry algorithms for 5 common nursing home problems, and tested their acceptance, use, and preliminary impact on quality indicators in 2 VA nursing homes.

Although providers were uniformly enthusiastic about the computerized order entry algorithms, they used them infrequently. The only computerized order entry algorithm used frequently was for falls, which may have occurred for several reasons. First, falls occur more frequently than the other conditions. Second, higher staff interest in fall prevention due to regulatory and legal implications may have driven use. Finally, post-fall evaluation generally occurs during regular working hours when the providers are in the facility and can easily access the computerized order entry algorithms. In contrast, orders for acute conditions such as fever or pneumonia are often given over the telephone if they occur when a provider is not present. Osteoporosis, the only target condition without an acute event to trigger its use, was rarely used despite large numbers of patients with a history of fracture in the homes. The statistically significant decline in several of the osteoporosis quality indicators therefore likely reflects the lower proportion of patients with recognized osteoporosis in the post-implementation group. It is not clear whether providers with more experience in using computerized order entry systems would be more or less likely to use the algorithms.

When computerized order entry algorithms were used frequently, as in the case of falls, we saw a trend toward clinically meaningful improvements in quality indicators. While larger, randomized controlled studies are necessary to determine whether the change in quality indicators will translate into improved processes and outcomes for residents, this result is important because prior studies of fall-prevention quality improvement programs have not been widely successful.[34, 41-44] The lack of success of previous quality improvement efforts may, in part relate to the need for coordination among multiple disciplines for multi-factorial fall risk reduction. Our computerized order entry algorithms provided a means for various groups to communicate efficiently, for example through automatic alerts sent to the pharmacist when the provider accessed the fall algorithm or through optional consults to physical and occupational therapy and nursing. Given the Joint Commission, State regulatory agency, and CMS's focus on fall prevention, we believe that the fall prevention computerized order entry algorithm merits further study as a means of post-fall assessment, and risk reduction for high risk residents.

The minimal impact on indicators for the acute and chronic conditions suggests that additional interventions might be necessary to prompt clinician use. For example, osteoporosis alerts

could automatically send providers information about patients with a prior fracture history or who take chronic corticosteroids. Because providers are frequently not present in the home when an acute illness occurs, training nurses to use the computerized order entry algorithms may increase their use and facilitate team communication. However, nurses were not allowed to place orders in the computer in one of the study homes, and scope of practice limitations in other facilities would require that providers still be contacted for verbal approval. Algorithm-based standing orders for fever or falls evaluation that are automatically initiated by nursing staff is another option, although this eliminates the customization to the specific resident's presentation and goals that is valued by nursing home providers.

Provider turnover is often cited as a barrier to clinical practice guideline use in nursing homes, and was indeed observed in our study. Interestingly, the impact of provider turnover differed in the 2 study facilities. In the academic center, new providers were trained to use the computerized order entry algorithms by the medical director (who was part of the study team) during orientation, and they welcomed the computerized order entry algorithms as a valuable tool to help them “learn the ropes”. They became more frequent users than the previous providers who were accustomed to the old system. Thus, staff turnover may actually represent an opportunity to introduce new technology such as computerized order entry algorithms, particularly if the nursing home medical director and other leaders are committed and supportive. In the second facility, provider turnover exceeded 100% (including 3 medical directors) during the study period, and the facility was frequently understaffed. In this challenging environment, computerized order entry algorithm use was minimal despite repeated reminders and visits. If computerized order entry algorithms are employed by a facility, we suggest incorporating training in their use to the routine employee orientation, and actively engaging the facility leadership in promoting their use.

Our study adds to the emerging literature on the use of information technology in improving nursing home care. A recent randomized study of computer decision support to reduce adverse drug events in nursing home residents found no significant benefit.[45] The authors hypothesize that limited scope of the medications covered, a high proportion of inappropriate provider alerts, and targeting of only the medical team members may have explained the lack of effect. Our study suggests that it is feasible to use computer order entry algorithms to enhance communication about geriatric syndromes with other team members (e.g., the pharmacist, therapist, and nursing staff in a patient with falls). While allowing providers to access order entry algorithms voluntarily avoids the problem of burdensome inappropriate reminders, it also may result in low use and therefore limited impact. Combining reminders to providers (e.g., reminder to screen/treat for osteoporosis triggered by an admission for hip fracture) with the appropriate computerized order entry page may allow the advantages of both strategies to be realized.

There are several limitations to this pilot study. First, it is small and the observed trends to improvement in falls quality indicators may be due to chance alone. Our pre-post study design does not allow us to make causal inferences. However, we sought to examine the feasibility and acceptance of these computerized order entry algorithms. Second, our study was conducted at VA nursing homes, which limits our generalizabitity. Notably, VA nursing homes have greater on-site availability of providers and an electronic order medical record system which may not be available in community nursing homes.

In summary, in this pilot test we successfully developed and implemented computerized order entry algorithms for common geriatric problems in 2 VA nursing homes. Despite high staff turnover, trends toward improvements in quality indicators were measured for the most frequently used computerized order entry algorithms (falls). This technology offers promise for improving clinical practice guideline use in nursing homes, but further modifications to

adapt to the community nursing home system, and to prompt use for chronic conditions are needed. Formal evaluation of computerized order entry algorithms in nursing homes requires a randomized trial.

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APPENDIX: Content of computerized order entry algorithms used in the study

I. FALLS

a. MULTIPLE RISK FACTOR REDUCTION

- **Acute illness suspected?**
  - ○ Metabolic panel
  - ○ Complete blood count
  - ○ Urinalysis, culture and sensitivity for fever, urinary symptoms ONLY
- **Medication review**
  - ○ Request medication review by Pharmacist for falls risk
  - ○ Link to medication order entry page
- Request **Physical Therapy evaluation** for falls prevention
- **Nursing Orders**
  - ○ Measure orthostatic vital signs × 1, record in medical record, notify provider if >= 15mm Hg drop in BP or >= 20 beat/min increase in HR
  - ○ Enroll in Falling Star Program
  - ○ Complete Nursing Fall Risk Reduction plan of care, if not done within previous 30 days
- Schedule **Ophthalmology Consult** for visual acuity change (if not done > 1 year)

b. INJURY PREVENTION

- Order **Calcium and vitamin D supplements**
- Order **External Hip Protectors**
- Link to **Osteoporosis** algorithm

II. FEVER

a. DIAGNOSIS

- Complete blood count
- Metabolic panel

- Urinalysis ONLY if 1 or more urinary symptoms or unexplained delirium
    - ○ Obtain midstream clean catch or condom catheter urine specimen for urinalysis, culture and sensitivity
    - ○ In and Out catheterization for urinalysis, culture and sensitivity ; document Post Void Residual Volume
    - ○ Aspirate drainage port of indwelling catheter for urinalysis, culture and sensitivity
- Suspected pneumonia, respiratory rate >20 breaths per minute, or oxygen saturation <90%
    - ○ Posterior-Anterior and lateral chest x-ray in Radiology (preferred if patient stable)
    - ○ Portable chest x-ray (if patient unable to tolerate transport)
    - ○ Sputum gram stain, culture and sensitivity
    - ○ Influenza nasal swab (if outbreak during November-April or local activity reported)
- Stool studies for abdominal signs/symptoms
    - ○ Stool culture for bloody diarrhea
    - ○ Clostridium difficile toxin × 3 (if antibiotic exposure in previous 30 days)
- Soft tissue cultures ONLY for pus. Do not swab skin ulcers.
- Blood cultures × 2 (suspected endocarditis, bacteremia in patient who does not desire hospitalization)

b. TREATMENT

i. **Nursing** orders

- Give extra glass of water with each med pass × 3 days
- Full vitals including respiratory rate and oxygen saturation every shift × 72 hours
- Acetaminophen tablet 650 mg po Q 6 HR PRN × 7 days
- Nutritional supplements, offer twice daily for 1 week
- Falls precautions × 3 days

ii. **Empiric Antibiotics**

Does patient have other unstable vital signs or signs/symptoms of severe infection?

NO: Await diagnostic test results, monitor patient closely

YES: Proceed to empiric antibiotic therapy

- Pneumonia [link to pneumonia page]
- Urinary Tract Infection [link to UTI page]
- Skin/soft tissue infection
    - ○ Cephalexin (uncomplicated cellulitis) 500 mg po Q 12 HR × 7 days
    - ○ Clarithromycin (alternate for penicillin allergic) 500 mg po Q 12 HR × 7 days
    - ○ Augmentin (diabetics with erysipelas, suspected osteomyelitis) 875/125 mg po Q 12 HR × 7 days
    - ○ Ciprofloxacin + Clindamycin (pressure ulcers with sepsis, alternate for suspected osteomyelitis) [Cipro 500 mg po Q 12 HR × 7 days + Clindamycin 600 mg po Q 12 HR × 7 days
- Gastrointestinal
    - ○ Diarrhea: Avoid empiric treatment for bloody diarrhea until culture results received due to possibility of inducing hemolytic uremic syndrome if infected with enterotoxigenic E. coli
        - ■ Metronidazole (high risk for

Clostridium difficile colitis) 500 mg po Q 12 H R × 7 days

○ Diverticulitis

■ Trimethoprim/Sulfamethoxazole DS tablet po Q 12 H R × 14

days

■ Cipro + Metronidazole [Cipro 500 mg po Q 12 HR × 14 days + Metronidazole 500 mg po Q 12 HR × 14 days

III. PNEUMONIA

a. Radiology

- Posterior-Anterior and lateral chest x-ray in Radiology (preferred if patient stable)
- Portable chest x-ray (if patient unable to tolerate transport)

b. Microbiology

- Sputum for gram stain, culture and sensitivity
- Urine for pneumococcal antigen
- Influenza nasal swab (if outbreak during November-April or local activity reported)

c. Laboratory Evaluation

- Complete blood count with differential
- Metabolic panel

d. Nursing Orders

- Oxygen by nasal cannula to keep saturation >90%
- Measure Vitals with Respiratory Rate and Oxygen saturation every shift for 48 hours, notify provider of significant change
- Give an extra glass of water with each med pass
- Fall precautions for 48 hours (link to Fall algorithm page)

e. Antibiotics

1. Moxifloxacin 400 mg po Q 12 HR × 7 days
2. Augmentin + Clarithromycin [Augmentin 875 mg po Q 12 HR × 7 days + Clarithromycin 500 mg po Q 12 HR × 7 days
3. Clindamycin + Clarithromycin (suspected aspiration) [Clindamycin 300 mg po Q 6 HR × 7 days + Clarithromycin 500 mg po Q 12 HR × 7 days]
4. Ceftriaxone IM (if known Strep. pneumoniae) 1 gm IM Q 24 HR
5. Rimantidine (known or suspected Influenza A within 48 hours of symptom onset) 100 mg po Q 12 HR × 5 days
6. Oseltamavir (known or suspected Influenza B, or intolerance to Rimantidine, within 48 hours of symptom onset) 75 mg po Q 12 HR × 5 days

f. Medications for Underlying Lung Disease Exacerbation

- Prednisone taper
- Albuterol by nebulizer QID and Q 1 HR prn
- Atrovent by nebulizer QID and Q 1 HR prn

IV. URINARY TRACT INFECTION

a. DIAGNOSTIC TESTING ONLY FOR SYMPTOMS: Does patient have SYMPTOMS of UTI or delirium without out other explanation?

NO: Do not order UA or treat for UTI

YES: Proceed to **Diagnosis**

- ○ Obtain midstream clean catch or condom catheter urine specimen for urinalysis, culture and sensitivity
- ○ In and Out catheterization for urinalysis, culture and sensitivity; document Post Void Residual Volume
- ○ Aspirate drainage port of indwelling catheter for urinalysis, culture and sensitivity

b. AVOID TREATMENT FOR ASYMPTOMATIC BACTERIURIA: Does patient have bacteriuria/pyuria AND temperature > 37.9° F (or 2.4° F above baseline temp) AND 1 or more urinary symptoms or change in clinical status?

NO: Do not treat for urinary tract infection

YES: Proceed to **Treatment;** look for prior culture results for antibiotic selection guidance

c. ANTIBIOTICS

- ○ Trimethoprim/Sulfamethoxazole DS tab po Q 12 HR × 7 days

Note to prescriber in box [Creatinine clearance: 15−30 ml/min: us single strength tabs;

Creatinine clearance: < 15 ml/min: Not recommended]

- ○ Ciprofloxacin 500 mg po Q 12 HR × 7 days

Note to prescriber in box [For uncomplicated infection, can use 250 mg.

Renal Dosing

Creatinine clearance: 30−50 ml/min: 250 mg PO Q12HR

Creatinine clearance: 5−29 ml/min: 250 mg PO Q18−24 HR]

- ○ Augmentin 500/125 mg po Q 12 HR × 7 days

Note to prescriber in box [Creatinine clearance 10−30 ml/min: 250 mg PO Q12HR

Creatinine clearance < 10 ml/min: 250 mg PO Q24 HR]

- ○ Ceftazadime IV 500 mg IV Q 12 HR (adjust for renal impairment)

Note to prescriber in box [for uncomplicated infection can use 250 mg IV/IM Q12HR. Creatinine clearance: 10−30 ml/min: Administer Q24HR

Creatinine clearance < 10 ml/min: Administer Q48−72 HR

- ○ Gentamicin IM 1 mg/kg IM Q 8 HR (Second line agent in select cases) Note to prescriber in box [adjust for renal impairment, goal peal level 5−10 mcg/ml, trough < 2 mcg/ml]
  - ■ Gentamicin peak level
  - ■ Gentamicin trough level

d. NURSING CARE

- ○ Give an extra glass of water with each med pass for 3 days
- ○ Exchange foley catheter
- ○ Falls precautions for 2 days (link to Falls algorithm)

e. OTHER ORDERS

- ○ Urology consult: recurrent urinary tract infection

V. OSTEOPOROSIS

a. Laboratory Evaluation

- Serum total calcium, serum albumin
- Thyroid stimulating hormone
- Testosterone
- Alkaline phosphatase
- 25,OH Vitamin D

b. Pharmacologic Treatment

- Calcium carbonate/vitamin D tablet 1 po BID with meals
- Vitamin D 50,000 unit cap po × 1 (for known or suspected vitamin D deficiency)
- Alendronate (First line: contraindicated Creatinine clearance<35, esophageal abnormalities, hypocalcemia) 70 mg po Q WK (administration instructions: take first thing in the morning with 8 oz of water, 30 minutes before ***any other medication,*** food or drink. Sit upright 30 minutes after dose)
- Calcitonin solution, nasal 1 spray intranasal Q 24 hrs (administration instructions: alternate nostrils)

c. Other Treatment

- Nutrition consult for osteoporosis
- PT consult for safe movement training
- Fall precautions (link to fall algorithms)
- External hip protectors on each morning

APPENDIX

APPENDIX

Individual site results for the quality indicators before and after algorithm implementation.

Variable	Academic Nursing Home		Non-Academic Nursing Home	
	PRE	POST	PRE	POST
	Fever			
	n=21	n=21	n=20	n=20
Full set of vitals except orthostatics (%)	57.1	71.4	35.0	65.0
Orthostatics (%)	4.8	4.8	0	0

Variable	Academic Nursing Home		Non-Academic Nursing Home	
	PRE	POST	PRE	POST
Clinical Evaluation Completed within 24 hrs (%)	71.4	61.9	80.0	90.0
GI symptoms documented (%)	28.6	23.8	50.0	30.0
Urinary sx documented (%)	9.5	9.5	20.0	10.0
If urinary symptoms are absent AND delirium absent, then no urinalysis ordered (%)	19.1	33.3	45.0	15.0
No antibiotics for viral syndrome (%)	100	n/a	n/a	n/a
Atibiotic dose adjusted for renal insufficiency (%)	33.3	14.3	n/a	66.7
	UTI			
	n=16	**n=15**	**n=17**	**n=14**
Only treatment for symptoms or unexplained delirium (%)	56.3	73.3	47.1	78.6
Recommended antibiotic prescribed (%)	62.5	26.7	64.7	64.3
Follow up cultures done only for symptoms (%)	37.5	60.0	40.0	50.0
Antibiotic dose adjusted for renal insufficiency (%)	40.0	12.5	0	0
	Pneumonia			
	n=10	**n=9**	**n=11**	**n=10**
Full set of vitals to include pulse ox and RR (%)	90.0	88.9	63.6	40.0
Clinical eval within 24 hours (%)	90.0	100.0	100.0	90.0
Orthostatics documented (%)	0	0	0	0
Recommended Antibiotic (%)	80.0	77.8	72.7	90.0
Antibiotic dose adjusted for renal insufficiency	66.7	100	100	100
	Falls			
	n=20	**n=20**	**n=20**	**n=20**
Full vitals, other than orthostatics	90.0	95.0	80.0	45.0*
Orthostatic BP recorded in 24 hours (%)	35.0	45.0	0	15.0 (p=.07)
PT eval within 6 months preceeding, or 3 months after fall (%)	60.0	40.0	50.0	55.0
Psychotropic medication use reduced, discontinued, or justified	75.0	66.8	50.0	66.7
Neuroleptics	80.0	100.0	37.5	66.7
Antidepressants	54.5	64.3	58.3	33.3
Benzodiazepines	100	n/a	66.7	69.2
Sedative-hypnotics	n/a	100	16.7	33.3
Calcium supplements (%)	45.0	60.0	0	5.0
Vitamin D supplements (%)	40.0	60.0	0	10.0
External hip protectors (%)	35.0	50.0	15.0	45.0*
	Osteoporosis			
	n=21	**n=16**	**n=20**	**n=20**
BMD measured (%)	33.3	31.3	40.0	5.0
Metabolic evaluation completed				
TSH	80.9	81.3	84.2	60.0
Testosterone	9.5	0	5.0	10.0
Calcium	100	100	100.0	55.0*
Vitamin D	14.3	18.8	5.0	5.0
Alkaline Phosphatase	57.1	50.0	100	50.0*
All of above	4.8	0	0	5.0

Variable	Academic Nursing Home		Non-Academic Nursing Home	
	PRE	POST	PRE	POST
Calcium prescribed (%)	71.4	37.5*	10.0	10.0
Vitamin D prescribed (%)	52.4	37.5	10.0	10.0
External hip protectors (%)	23.8	31.3	0	0
Osteoporosis medication (%)	14.3	6.3	15.0	0
Physical Therapy Prescribed (%)	57.1	87.5*	45.0	60.0

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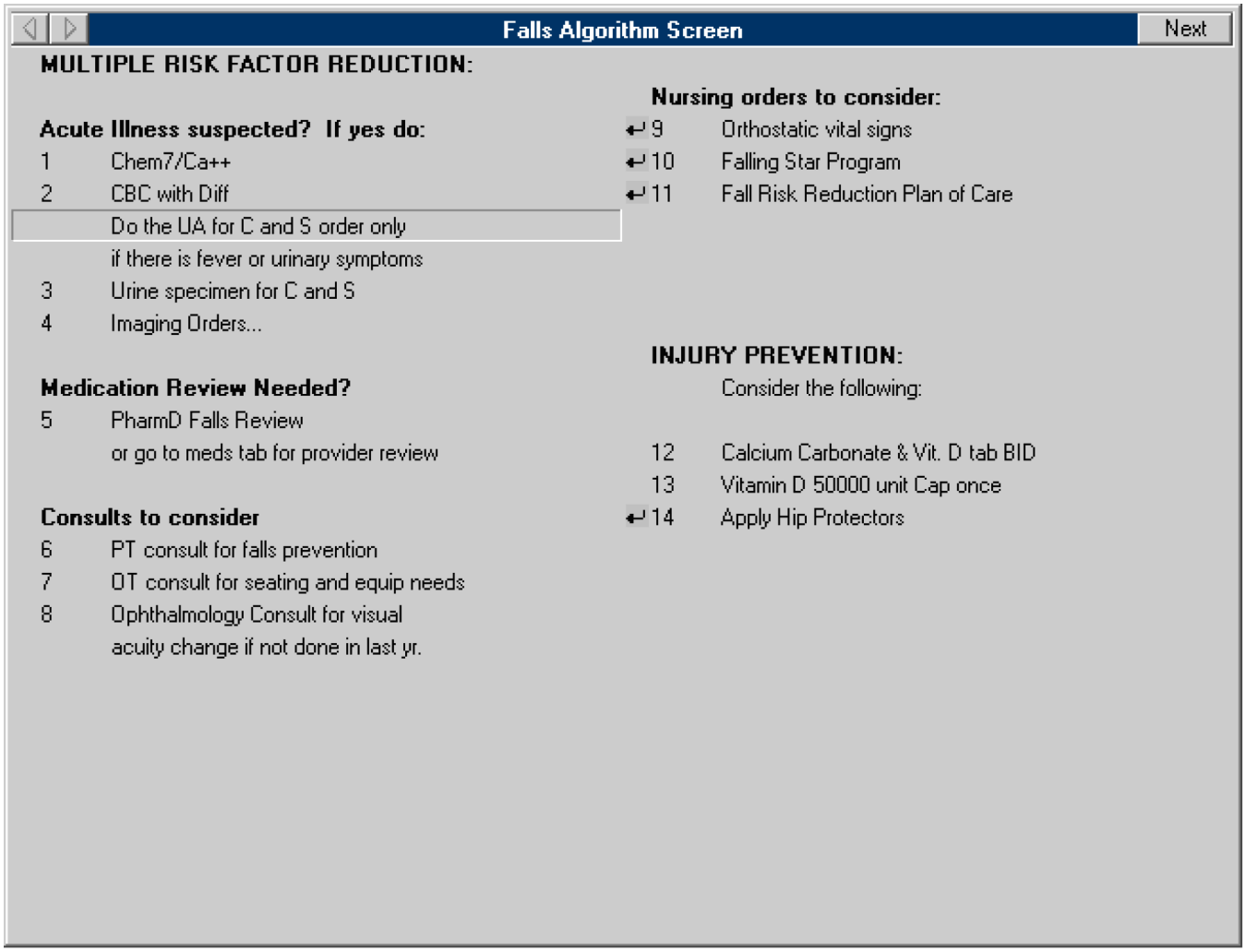

Figure 1.
Computerized order entry algorithm screen for fall prevention. Clicking on the line generates an automatic order that can be edited if desired.

Table 1

Subject Characteristics Before and After Order Entry Algorithm Use

Variable	Before Implementation N=148	After Implementation N=117
Mean Age (yrs)	72.2	72.8
Male (%)	95.9	98.3
White (%)	44.8	42.6
Long Term Care (%)	55.6	55.8
No care-limiting advanced directives (%)	29.2	33.6
Obstructive Lung Disease (%)	28.4	35.9
Congestive Heart Failure (%)	16.2	18.8
Dementia (%)	55.4	55.6
Stroke (%)	33.8	27.4
Active cancer diagnosis (%)	20.3	23.1
Chronic kidney disease (%)	21.6	28.2

Table 2

Problem Characteristics Before and After Order Entry Computerized order entry algorithms Implementation

Variable	Before Implementation	After Implementation
Falls	**N=40**	**N=40**
Psychotropic medications (%)	65.9	79.5
Fever	**N=42**	**N=41**
Delirium (%)	22.0	31.7
Urinary symptoms (%)	14.6	9.8
GI symptoms (%)	39.0	26.8
Clinical Diagnosis (%)		
Pneumonia	24.4	31.7
Urinary infection/pyelonephritis	31.7	29.3
Viral syndrome	9.8	0
Clostridium difficile	17.1	7.3
Unknown/other	24.3	21.9
Antibiotics prescribed (%)		
Penicillins	53.6	56.1
Cephalosporins	19.5	31.7
Quinolones	17.1	17.1
Anti-anaerobes	22.0	26.8
Pneumonia	**N=35**	**N=21**
Hypoxia (%)	38.1	42.1
Respiratory Symptoms (%)	57.1	84.2*
Delirium (%)	33.3	63.2
Stable vital signs (%)	23.8	31.6
Urinary Tract Infection	**N=31**	**N=31**
Catheter-related (%)	36.4	51.7
Any urinary symptoms (%)	39.4	41.9
Fever (%)	57.6	69.0
Organism sensitive to initial antibiotic (%)	42.4	41.4
Osteoporosis	**N=41**	**N=37**
Prior fracture (%)	82.9	100†

† p<0.05

* p<0.10

Table 3

Quality Indicators Before and After Order Entry Algorithm Implementation

Variable	Before Implementation	After Implementation	p value*
Falls	**N=40**	**N=40**	
Full set of vitals (%)	85.0	70.0	0.18
Orthostatic BP (%)	17.5	30.0	0.29
PT evaluation (%)	55.0	47.5	0.65
Psychotropic medications reduced, discontinued, or justified (%)	61.5	66.7	0.78
Neuroleptics	53.8	75.0	0.27
Antidepressants	56.5	55.0	0.24
Benzodiazepines	77.8	69.2	0.34
Sedative-hypnotics	16.7	50.0	0.30
Calcium supplements (%)	22.5	32.5	0.45
Vitamin D supplements (%)	20.0	35.0	0.21
External hip protectors (%)	25.0	47.5	0.06
Fever	**N=42**	**N=41**	
Full set of vitals (%)	46.3	68.3	0.07
Orthostatic BP (%)	2.4	2.4	1.0
MD/NP evaluation within 24 hr (%)	75.6	75.6	1.0
If no urinary symptoms or delirium, then no urinalysis (%)	31.7	24.9	0.62
No antibiotics viral syndrome (%)	100	n/a	n/a
Antibiotic dose adjusted (%)	28.6	23.1	1.0
Urinary Tract Infection	**N=31**	**N=31**	
Only treatment for symptoms or unexplained delirium (%)	51.5	75.9	0.07
Recommended antibiotic (%)	63.6	44.8	0.20
Follow up cultures only for symptoms (%)	38.5	57.1	0.64
Antibiotic dose adjusted (%)	40.0	27.3	0.38
Pneumonia	**N=35**	**N=21**	
Full set of vitals (%)	76.2	63.2	0.49
MD/NP evaluation within 24 hr (%)	95.2	94.7	1.0
Orthostatics documented (%)	0	0	n/a
Recommended Antibiotic (%)	76.2	84.2	0.69
Antibiotic dose adjusted (%)	80	100	0.56
Osteoporosis	**N=41**	**N=37**	
Metabolic evaluation (%)			
TSH	81.5	69.4	0.29
Testosterone	7.3	2.6	0.34
Calcium	100	75.0	0.05
25(OH)Vitamin D	9.8	11.1	1.0
Alkaline phosphatase	78.1	50.0	0.02
All tests above	2.4	2.8	1.0
Calcium prescribed (%)	41.5	22.2	0.09
Vitamin D prescribed (%)	31.7	22.2	0.44
External hip protectors (%)	12.2	13.9	1.0
Osteoporosis medication (%)	7.3	2.8	0.61
Physical Therapy Prescribed (%)	51.2	72.2	0.07

* Based on Fisher's Exact Test