TITLE PAGE

AHRQ Final Progress Report

Title: Enhancing the Detection and Management of Adverse Drug Events in the Nursing Home

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STRUCTURED ABSTRACT

Purpose: To determine the impact on adverse drug event (ADE) detection and management when nursing home (NH) residents are cared for by physicians who received recommendations from a consultant pharmacist (CP) using an active medication monitoring system for ADE surveillance.

Scope: Four nonprofit NHs, academically affiliated and not part of a national chain.

Methods: Pre-and-post intervention surveys of CP importance and performance were conducted. Throughout the 9-month trial, in addition to the federally mandated 30-day medication regimen reviews MRRs (i.e., usual care), CPs responded to alerts from the active medication monitoring system, adjudicated the alert for a potential ADE, and provided structured recommendations to intervention physicians about ADE management using the SBAR structured communication framework. For the usual care group, the CP did not use the active medication monitoring system but did continue with the MRRs.

Results: All questions for *importance* increased in scores for the intervention group, and five questions resulted in a significant change ($p<0.05$). The intervention group had positive average changes for all performance questions, and 20 were significant. During the study, 1351 potential ADE alerts were adjudicated, and the most common were hypoglycemia (n=511); acute kidney injury (AKI; n=274); AKI risk (n=140); hypokalemia (n=123); and elevated INR (n=101). Overall, 41.2% (557 of 1351) of the potential ADE alerts were considered definitely or probably preventable, with prescribing being the most common error detected 49.68% (544 of 1094). The most common actions taken were ordering labs (50.16%; 630 of 1256), stopping drugs (185 of 1256), and changing dosages (13.85%; 174 of 1256). The distribution of responses by group was 347 in the intervention group and 606 in the usual care group. Physicians in the intervention group responded to alerts much faster than in the usual care group; 50% of the time, the median response was <2.5 days for the intervention group and 6 days for the usual care group.

Key words: nursing homes, adverse drug events, clinical decision support systems

PURPOSE:

The ***long-term objective*** of our proposed research is to improve patient safety with respect to medications in nursing homes (NHs). Our ***short-term objectives*** are to build upon our prior experience to further refine, implement, and evaluate the impact of our active medication monitoring system on the quality and efficiency of healthcare. We conducted the AHRQ-sponsored research over a 4-year period in four NHs with heterogeneous facility, patient, and physician characteristics. To accomplish these short-term objectives, we designed the following ***outcomes***:

- The **primary outcome** is to determine if physicians who receive active medication monitoring alerts from medication safety pharmacists:
    1. ***have more ADEs detected and managed*** compared with physicians providing usual care in the NH.
    2. ***have a faster ADE management response time*** compared with physicians providing usual care in the NH.
- The **secondary outcome** is to determine the perceived *importance* and *performance* of the pharmacy service provided in the intervention compared with the control group.

SCOPE (Background, Context, Settings, Participants, Incidence, and Prevalence):

Adverse drug events (ADEs) are defined by the Institute of Medicine (IOM) as injuries resulting from a medical intervention related to a drug. (1) These events are the most clinically significant and costly medication-related problems in NHs and are associated with an estimated 93,000 deaths a year and as much as $4 billion of excess healthcare expenditures. (2-4) Data on ADEs in NHs suggest that about half of these events are preventable, and most preventable ADEs (70-80%) are associated with *monitoring* (i.e., assessing response to a medication and documenting outcomes) rather than *prescribing* errors. (5, 6) Nevertheless, the majority of health information technology (HIT) interventions to improve patient safety with respect to medications have focused on enhancing prescribing through the use of computerized provider order entry (CPOE) with clinical decision support (CDS). (7-10) CPOEs with CDS interventions have had varying degrees of success in detecting and reducing ADEs in diverse clinical settings, including NHs. (3, 11)

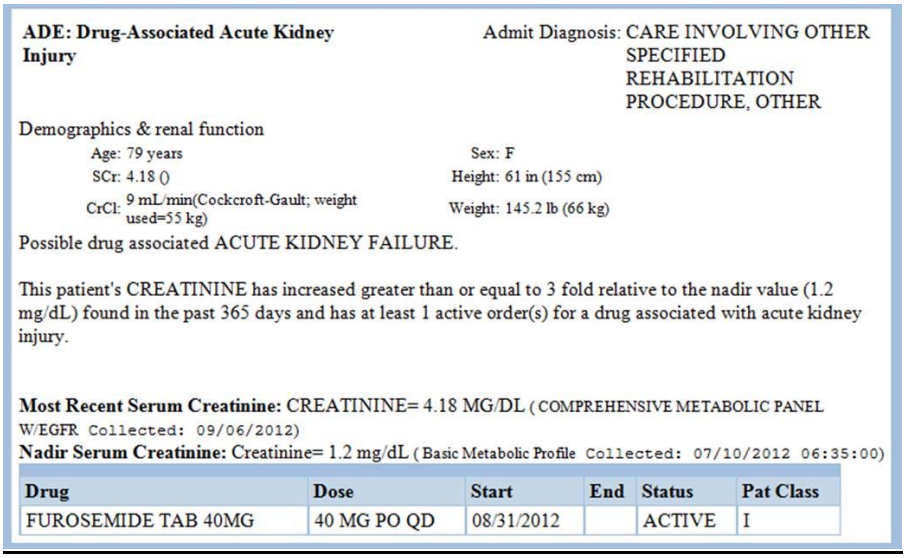
The IOM and other patient safety organizations recommend that all healthcare settings assess the safety of medication use through active monitoring within a culture of safety. (12-19) Active medication monitoring systems are particularly needed to detect ADEs in priority populations such as institutionalized elderly because of the long-standing concern about the quality of their pharmaceutical care. (20) Moreover, about one third of NH patients (i.e., residents) meet the Centers for Medicare & Medicaid Services (CMS) definition of polypharmacy ($\geq$9 medications per day), placing them at high risk for ADEs, and the ability to monitor

prescribed medications effectively in the NH is limited by an insufficient healthcare workforce, high staff turnover, and a poorly developed safety culture. (21-26)

Our multidisciplinary team of geriatricians, pharmacists, nurses, biomedical informaticians, health services researchers, and policy analysts developed and pilot tested an active medication monitoring system to automate the detection of ADEs in a single community-based NH that had no pre-existing advanced HIT system. In preliminary research, we found that ADEs can be detected with a high degree of accuracy, at a rate of nearly 2.5 times greater than that of *usual care* (i.e., pharmacist-conducted manual chart review with mandated reporting to attending physician for assessment and clinical intervention). (27, 28)

METHODS (Study Design, Data Sources/Collection, Interventions, Measures, Limitations):

As part of the medication safety pharmacist led intervention, consultant pharmacists (CPs) first provided academic detailing to intervention physicians describing the frequency, clinical significance, preventability, and impact including cost of ADEs in the NH setting. Throughout the 9-month trial, in addition to the federally mandated 30-day MRRs (i.e., usual care), CPs responded to alerts from the active medication monitoring system (Figure 1), adjudicated the alert for a potential ADE,



ADE: Drug-Associated Acute Kidney Injury

Admit Diagnosis: CARE INVOLVING OTHER SPECIFIED REHABILITATION PROCEDURE, OTHER

Demographics & renal function

Age: 79 years
Sex: F
SCr: 4.18 ()
Height: 61 in (155 cm)
CrCl: 9 mL/min(Cockcroft-Gault; weight used=55 kg)
Weight: 145.2 lb (66 kg)

Possible drug associated ACUTE KIDNEY FAILURE.

This patient's CREATININE has increased greater than or equal to 3 fold relative to the nadir value (1.2 mg/dL) found in the past 365 days and has at least 1 active order(s) for a drug associated with acute kidney injury.

Most Recent Serum Creatinine: CREATININE= 4.18 MG/DL (COMPREHENSIVE METABOLIC PANEL W/EGFR Collected: 09/06/2012)
Nadir Serum Creatinine: Creatinine= 1.2 mg/dL (Basic Metabolic Profile Collected: 07/10/2012 06:35:00)

Drug	Dose	Start	End	Status	Pat Class
FUROSEMIDE TAB 40MG	40 MG PO QD	08/31/2012		ACTIVE	I

Figure 1. Sample Adverse Drug Event Alert

and provided structured recommendations to intervention physicians about ADE management using the SBAR (situation, background, assessment, and recommendation) structured communication framework (Figure 2). For the usual care group, the CP did not use the active medication monitoring system but did continue with the 30-day reviews mandated by the Federal Regulations.

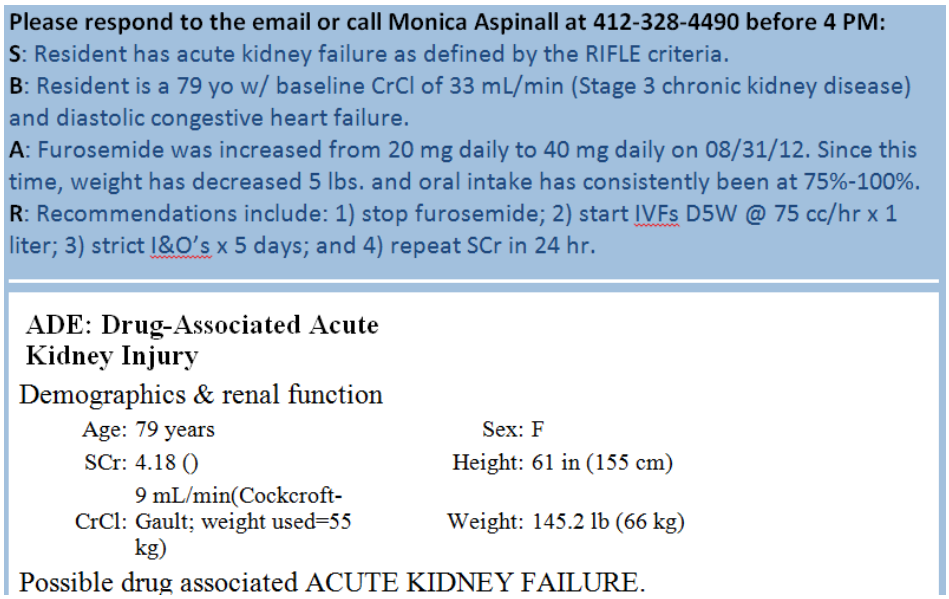


Figure 2. Sample Adverse Drug Event Alert with SBAR Message to the Physician

Setting

Four UPMC-owned NHs were included in the RCT. UPMC NHs are nonprofit, academically affiliated, and not part of a national chain; two are in an urban setting, and two are in suburban settings. The average number of beds in these NHs is 141 (range, 50-179). This study was approved by the University of Pittsburgh IRB.

Survey

Pre- and post-intervention surveys were conducted for all participating physicians. A published and validated survey containing 21 questions pertaining to CP services was used as the basis for our evaluation. (29) We included 18 of the 21 questions from the Clark et al. survey. All questions used a five-point Likert scale and ranged from "Not at all Important" to "Extremely Important" for questions relating to *importance*, and "Poor" to "Excellent" for questions relating to *performance*. The survey used is as follows:

	COLUMN 1: IMPORTANCE					**COLUMN 2: PERFORMANCE**				
Factor	**Not at all Important** ▼				**Extremely Important** ▼	**Poor** ▼				**Excellent** ▼
1. Monitors and reports significant drug-drug interactions……..	1	2	3	4	5	1	2	3	4	5

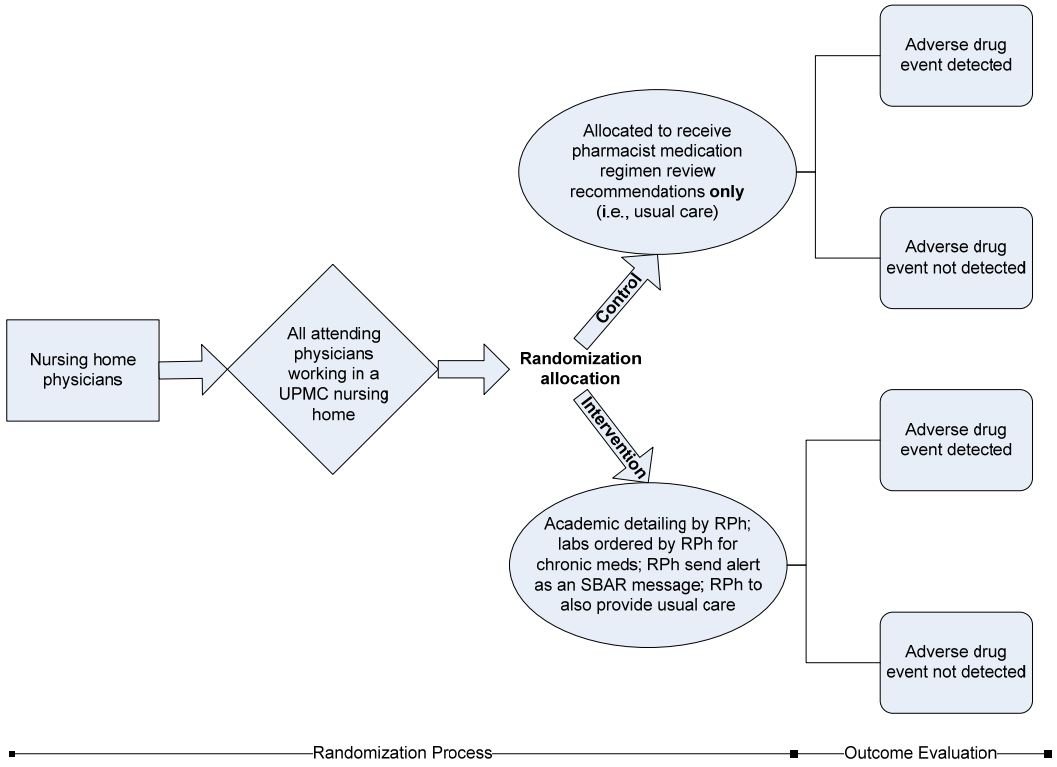
2. Conducts medication review in a timely manner….....	1	2	3	4	5	1	2	3	4	5
3. Monitors overall safety of drug therapy…….……	1	2	3	4	5	1	2	3	4	5
4. Recommends appropriate lab work to monitor drug therapy……..……..……	1	2	3	4	5	1	2	3	4	5
5. Recommends appropriate changes to drug regimen	1	2	3	4	5	1	2	3	4	5
6. Monitors effectiveness of drug therapy……	1	2	3	4	5	1	2	3	4	5
7. Monitors cost-effectiveness of drug therapy……..	1	2	3	4	5	1	2	3	4	5
8. Identifies residents at risk for disease and recommends appropriate intervention…….....	1	2	3	4	5	1	2	3	4	5
9. Provides disease-management services……	1	2	3	4	5	1	2	3	4	5
10. Provides and periodically updates facility policies and procedures……..……..	1	2	3	4	5	1	2	3	4	5
11. Assists facility with controlled substances accountability……....	1	2	3	4	5	1	2	3	4	5
12. Detects and manages adverse drug events……...	1	2	3	4	5	1	2	3	4	5
13. Assists facility with infection control……	1	2	3	4	5	1	2	3	4	5
14. Participates in appropriate facility committee meetings……	1	2	3	4	5	1	2	3	4	5
15. Provides written reports to facility on medication use patterns…….....	1	2	3	4	5	1	2	3	4	5
16. Helps facility minimize drug spending on Medicare Part A…….....	1	2	3	4	5	1	2	3	4	5
17. Helps facility comply with state and federal regulations…….	1	2	3	4	5	1	2	3	4	5
18. Monitors and reports medication errors……..	1	2	3	4	5	1	2	3	4	5
19. Comes to the facility during state surveyor visits……	1	2	3	4	5	1	2	3	4	5
20. Available for consultation between regular facility visits…….....	1	2	3	4	5	1	2	3	4	5

21. Identifies facilities educational and informational needs about medications and provides informational resources when needed…….....	1 2 3 4 5	1 2 3 4 5
22. Trains staff on commonly used medications in nursing facilities……...	1 2 3 4 5	1 2 3 4 5
23. Trains staff on proper administration of medication…….	1 2 3 4 5	1 2 3 4 5
24. Monitors and reports an increased **risk** for developing adverse drug events……....	1 2 3 4 5	1 2 3 4 5

Physicians Surveyed

In total, 36 UPMC NH attending physicians were randomized to the intervention (n=17) and control (n=15) groups. Physicians were requested to complete the 24-item survey for consideration of importance and performance of the CP services provided in the RCT. A description of the study design is provided in Figure 3.

Figure 3: Study design for cluster randomized controlled trial



RESULTS:

Physician Characteristics

All 36 physicians responded to the pre-intervention survey (72% were men). Their medical specialties were internal medicine (58%) and family medicine (42%). Forty-seven percent of physicians completed a fellowship, with 22% in geriatrics and 25% in pharmacy/pharmacology. The majority (75%) had added qualifications in geriatrics. The mean number of hours each physician spent on clinical activities in the nursing home was 7.4 (SD 5.8). Overall, 17 physicians and 15 physicians responded to both the pre and post surveys in the intervention and control groups, respectively, for a response rate of 88.9% (32/36) for the second round of the study. Additional details about the respondent can be found in **Table 1** below.

Table 1. Physician Characteristics

	All Respondents N=(36) n (%)	**Intervention Physicians** N=20 n (%)	**Control Group Physicians** N=16 n (%)	**P Value**
Gender - Male	26 (72.2)	14 (70)	12 (75)	0.2775
Degree				
MD	34 (94.4)	20 (100)	14 (87.5)	0.1905
DO	2 (5.6)	0 (0)	1 (12.5)	
Residency				
Family Medicine	15 (41.7)	10 (50)	5 (31.3)	0.2568
Internal Medicine	21 (58.3)	10 (50)	11 (68.8)	
Fellowship				
Geriatric Medicine	6 (22.3)	5 (25)	3 (18.75)	0.9088
Pharmacy/Pharmacology	9 (25)	5 (25)	4 (25)	
Not Completed	19 (52.8)	10 (50)	9 (56.3)	

Years Since Training Complete				
1	3 (8.3)	3 (15)	0 (0)	0.0002
2	2 (5.6)	0 (0)	2 (12.5)	
3	10 (27.8)	8 (40)	2 (12.5)	
4	6 (16.7)	2 (10)	4 (25)	
5	7 (19.4)	3 (15)	4 (25)	
6	8 (22.2)	4 (20)	4 (25)	
Certified Geriatrician	9 (25)	6 (30)	3 (18.8)	0.2306
LTC Hours Weekly * avg. (SD)	7.4 (5.8)	7.4 (5.6)	7.5 (6.1)	0.9236

Importance of CP Services

For the 24 questions asked to the intervention group of physicians, a significant mean change in importance occurred only for five questions, with questions 9, 10, 19, and 21 having a p value of <0.05 and question 14 having a p value of <0.01. Statistically significant improvement occurred for the following: provides disease management services; provides and periodically updates facility policies and procedures; participates in appropriate facility committee; comes to the facility during state surveyor visits; identifies educational and informational needs about medications; and provides information resources when needed. All the survey questions (n=24) for importance increased in scores for the intervention group, with mean changes ranging from 0.1 to 0.8. Sixteen of the 24 survey questions increased in scores, with changes ranging from 0.1 to 0.5 for the control group of physicians, and none of the mean changes were significant.

Performance of Consultant Pharmacist Services

The intervention group of physicians responded in a positive manner to 24 of the questions for performance after the intervention, with mean changes ranging from 0.4 to 1.1. The mean changes were significant for 20 of the questions, with 16 questions having a p value of <0.05 and with four having a p value of <0.10. Thirteen of the 24 survey questions increased in scores, with changes ranging from 0.1 to 0.6 for the control group of physicians, and none of the mean changes were significant**.**

Comparison of Pre and Post Survey Results between Intervention and Control Groups

All the mean changes for perceived performance for the intervention group was either at least the same (n=1 question) to greater (n=22 questions) compared with the control group, with the exception of one question, number 27, for which the control group had a larger mean positive change.

Potential Adverse Drug Event Alerts and Alert Distribution

During the study, 1350 potential ADE alerts were adjudicated, and their distribution is described in **Table 2** below. The medication distribution for therapeutic drug monitoring included digoxin (n=32); vancomycin (n=19); phenytoin (n=11); levetiracetam (n=5); valproic acid (n=4); amitriptyline (n=1); nortriptyline (n=1); tacrolimus (n=1); and theophylline (n=1).

Table 2. *Potential Adverse Drug Event Alert Distribution by Frequency*

Alert Name	***Alert Frequency***	***Percent***
Hypoglycemia	511	37.82%
AKI injury	274	20.28%
AKI risk	140	10.36%
Hypokalemia	123	9.10%
INR, elevated	101	7.48%
Therapeutic drug monitoring	75	5.55%
Hyperkalemia	44	3.26%
Hyponatremia	43	3.18%
AKI failure	17	1.26%
Hyperglycemia	16	1.18%
Hyperthyroidism	6	0.44%
Hypothyroidism	0	0%

AKI=acute kidney injury

National Coordinating Council for Medication Error Reporting and Prevention (NCC-MERP) ADE Classification

The NCC-MERP adopted a Medication Error Index that classifies an error according to the severity of the outcome. Like others, we have adopted this same classification to also describe ADEs. (30) The index considers factors such as whether the potential ADE reached the patient, if the patient was harmed, and to what degree. **Table 3** lists the distribution of potential ADE alerts and frequencies by NCC-MERP category.

Table 3. National Coordinating Council for Medication Error Reporting and Prevention ADE Classification		
NCC-MERP Category	***Frequency***	***Percent***
Category C: Did not require additional monitoring or an intervention	199	14.73%
Category D: Required additional monitoring	1010	74.76%
Category E: Caused temporary harm that required intervention	311	23.02%
Category F: Resulted in prolonged SNF stay and/or hospitalization	0	0%
Category G: Contributed to or resulted in permanent resident harm	0	0%
Category H: Required intervention to sustain the resident's life	4	0.30%
Category I: Contributed to or resulted in resident death	0	0%

Preventability of Potential Adverse Drug Event Alerts

Overall, 41.2% (557 of the 1351) of the potential ADE alerts were considered definitely or probably preventable (**Table 4** below).

Table 4. Preventability of Alerts Associated with Adjudicated Adverse Drug Event Alerts		
Preventability	***Frequency***	***Percent***
Definitely Preventable	31	2.29%
Probably Preventable	526	38.93%
Probably Not Preventable	784	58.03%
Definitely Not Preventable	3	0.22%

Stage(s) of the Medication Use Process Associated with a Potential Adverse Drug Event Alert

Each of the potential ADE alerts considered either definitely or probably preventable was considered to have an error in the medication use process. The medication use process is defined as the set of steps that include prescribing, dispensing, order communication, administration, and monitoring. There were 1094 errors in the medication use process associated with the 557 potential ADE alerts, which are listed in **Table 5** below.

Table 5. Stage(s) of the Medication Use Process Where the Alert		
Medication Use Process	***Frequency***	***Percent***
Prescribing	544	49.68%
Dispensing	289	26.39%
Monitoring	261	23.83%
Order Communication	0	0%
Administration	0	0%

Physician Action Following a Potential Adverse Drug Event Alert

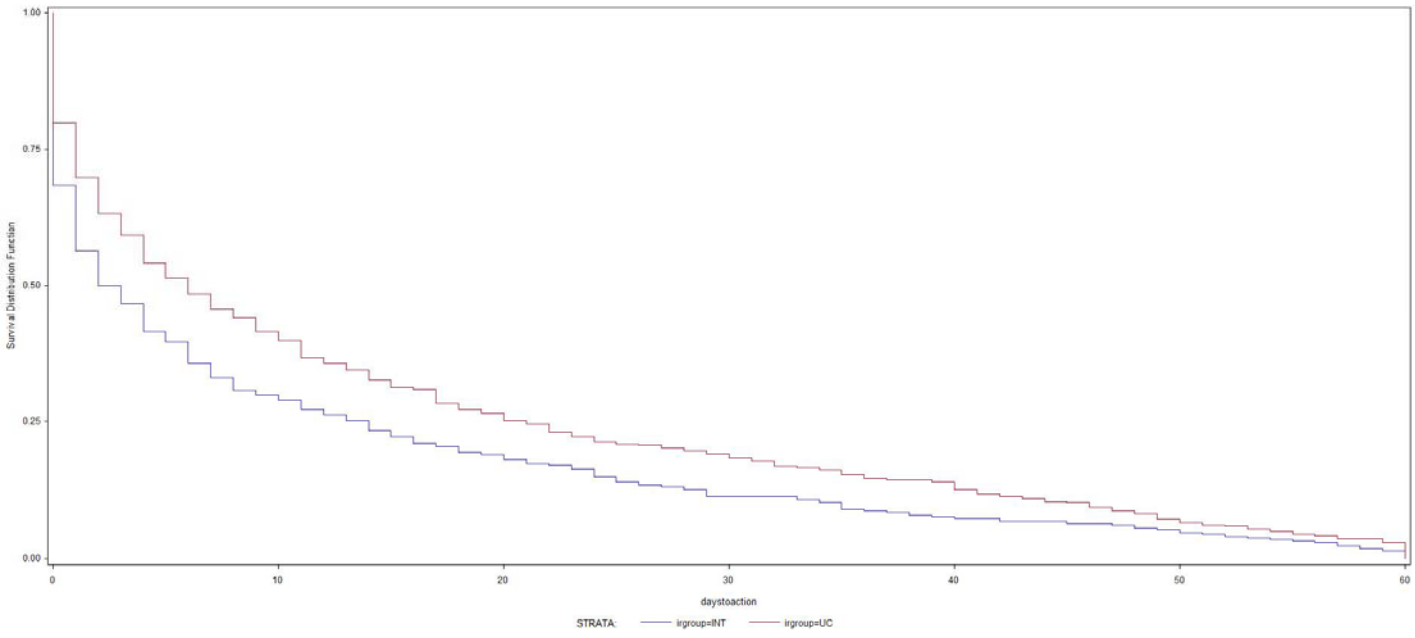
Of the 1351 alerts generated, 72.6% (983 of 1351) resulted in at least one action following a potential ADE alerts. Because a physician could take more than one response following an alert, the total number of actions was 1256; responses are described in **Table 6**.

Table 6. How Physicians Responded to Alerts Generated (not mutually exclusive)		
Response	***Frequency***	***Percent***
Ordered Labs	630	50.16%
Stopped a Drug	185	14.73%
Changed Dosage	174	13.85%
Started a Drug	87	6.93%
Changed a Drugs Directions	73	5.81%
Transfer to ED/Hospital	70	5.57%
Other Action	33	2.63%
Nursing Intervention	2	0.16%
Changed Formulation	1	0.08%
Clinical Assessment	1	0.08%
Changed Administration Schedule	0	0.00%

The distribution of responses by group was 347 in the intervention group and 606 in the usual care group. In the intervention group, physicians acted on 347 alerts per 56,542 person-days. In the usual care group, physicians acted on 606 alerts per 68,830 person-days.

Physician Time to Action

Overall, physicians in the intervention group responded to alerts much faster than did those in the usual care group, as seen in the Kaplan-Meier plot below (**Figure 4**). For example, in the intervention group, for 50% of the time, the median response time was <2.5 days, and for 75% of the time it was <14 days. Conversely, in the usual care group, for 50% of the time, the median response time was 6 days, and for 75% of the time it was 21 days.



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