Published in final edited form as:

Infect Control Hosp Epidemiol. 2015 November ; 36(11): 1268–1274. doi:10.1017/ice.2015.192.

The Effect of Contact Precautions on Frequency of Hospital Adverse Events

Lindsay D. Croft, MS¹, Michael Liquori, MD^{2,5}, James Ladd, MD¹, Hannah Day, MS, PhD¹, Lisa Pineles, MA¹, Elizabeth Lamos, MD², Ryan Arnold, MD², Preeti Mehrotra, MD⁴, Jeffrey C. Fink, MD, MS^{1,3,5}, Patricia Langenberg, PhD¹, Linda Simoni-Wastila, BSPHarm, MSPH, PhD⁶, Eli Perencevich, MD, MS^{7,8}, Anthony D. Harris, MD, MPH^{1,5}, and Daniel J. Morgan, MD, MS^{1,5}

¹Department of Epidemiology and Public Health, University of Maryland School of Medicine, Baltimore, Maryland ²Department of Medicine, University of Maryland Medical Center, Baltimore, Maryland ³Department of Medicine, Division of General Internal Medicine, University of Maryland School of Medicine, Baltimore, Maryland ⁴Division of Infectious Diseases, Department of Medicine, Boston Children's Hospital, Boston, Massachusetts ⁵VA Maryland Healthcare System, Baltimore, Maryland ⁶Department of Pharmaceutical Health Services, University of Maryland School of Pharmacy, Baltimore, Maryland ⁷Carver College of Medicine, University of Iowa, Iowa City, Iowa ⁸Iowa City Veterans Affairs Health Care System, Iowa City, Iowa

Abstract

OBJECTIVE—To determine whether use of Contact Precautions on hospital ward patients is associated with patient adverse events.

DESIGN—Individually-matched prospective cohort study.

SETTING—The University of Maryland Medical Center, a tertiary care hospital in Baltimore, Maryland.

METHODS—A total of 296 medical or surgical inpatients admitted to non-intensive care unit hospital wards were enrolled at admission from January to November 2010. Patients on Contact Precautions were individually matched by hospital unit after an initial 3-day length of stay to patients not on Contact Precautions. Adverse events were detected by physician chart review and categorized as noninfectious, preventable and severe noninfectious, and infectious adverse events during the patient's stay using the standardized Institute for Healthcare Improvement's Global Trigger Tool.

RESULTS—148 patients on Contact Precautions at admission were matched to 148 patients not on Contact Precautions. Of the total 296 subjects, 104 (35.1%) experienced at least one adverse event during their hospital stay. Contact Precautions were associated with fewer noninfectious adverse events (rate ratio [R_rR], 0.70; 95% confidence interval [CI], 0.51–0.95; p=0.02) and non-statistically significant fewer severe adverse events (R_rR, 0.69; 95% CI, 0.46–1.03; p=0.07).

Preventable adverse events (RR, 0.85; 95% CI, 0.59–1.24; $p=0.41$) did not significantly differ between patients on Contact Precautions compared to unexposed patients.

CONCLUSIONS—Hospital ward patients on Contact Precautions were less likely to experience noninfectious adverse events during their hospital stay than patients unexposed to Contact Precautions.

Introduction

Contact Precautions are a transmission-based infection control method recommended by the Centers for Disease Control and Prevention (CDC). Contact Precautions require donning gowns and gloves prior to contact with the patient or patient's environment for patients known to be colonized or infected with antibiotic resistant organisms, in addition to cohorting or placing the patient in a single room.¹

Adverse events are unintentional injuries related to medical or surgical care not due to an underlying condition.² Adverse events include healthcare-associated infections (HAIs) as well as delirium, falls, renal injury, and other noninfectious adverse events.³ One to 2.4 million hospital adverse events are estimated to occur each year in the US⁴ and contribute to 98,000 inpatient deaths annually.⁵ In the United States, preventable adverse events are estimated to cost at least \$17 to \$29 billion per year.⁵

There may be unintended consequences of Contact Precautions. For example, healthcare personnel have consistently been shown to visit patients on Contact Precautions significantly less often than patients unexposed to Contact Precautions.^{6–8} In addition, adverse events may occur more frequently among patients on Contact Precautions. Stelfox and colleagues reported that patients on Contact Precautions experienced more than twice the rate of adverse events of patients unexposed to Contact Precautions and experienced seven times more preventable adverse events.⁹ However, a case-crossover study found no significant difference in adverse events when patients on Contact Precautions were compared to the same patients in an earlier time period when Contact Precautions were not used.¹⁰ Other studies have reported significant associations only between Contact Precautions and very specific subtypes of adverse events such as hyperglycemia.¹¹

Past studies of the adverse effects associated with Contact Precautions have been limited by use of non-standard definitions of adverse events (for example, electrolyte imbalances or very specific subtypes of events).^{9,11} Whether Contact Precautions are associated with the occurrence of any adverse events remains unresolved.

To investigate whether Contact Precautions are associated with the occurrence of adverse events, we conducted a prospective cohort study of patients on Contact Precautions matched to patients unexposed to Contact Precautions using a standard evaluation tool.

Methods

Study Design

The study was a prospective cohort of general medical and surgical patients recruited at the University of Maryland Medical Center, an academic tertiary care hospital. The patients in this study were initially recruited between January 2010 and November 2010 for a prospective study of the relationship between Contact Precautions and depression, anxiety, and patient satisfaction.^{12,13} Patients on Contact Precautions were individually matched to patients unexposed to Contact Precautions by a minimum three-day hospital length of stay and by admission service (to limit bias related to patients on Contact Precautions having longer length of stay and more severe illness). Study participants on Contact Precautions remained on Contact Precautions for the duration of their hospital stay and patients unexposed to Contact Precautions also did not change Contact Precautions exposure status during the study period. This study was approved by the Institutional Review Board of the University of Maryland, Baltimore.

Measurements and Outcomes

Demographic data such as age, gender, education, minority status (Hispanic and/or non-white race) and marital status were collected at study enrollment, while Charlson comorbidity score and length of stay were obtained from the hospital central data repository. We defined adverse events as “unintended physical injury resulting from or contributed to by medical care that requires additional monitoring, treatment, or hospitalization or that results in death” as used by the Institute for Healthcare Improvement (IHI) Global Trigger Tool.² We did not consider events due to the patient’s underlying condition as adverse events. Adverse events were identified using the IHI Global Trigger Tool which is a standardized method for completion of structured medical record reviews within approximately 20 minutes.² The trigger tool detects more adverse events than approaches such as the Agency for Healthcare Research and Quality (AHRQ) Patient Safety Indicators or hospital reporting systems.^{14,15} Three initial reviewers used the trigger tool to review the patient charts of all members of the cohort for adverse events. One initial reviewer (L.D.C.) reviewed the records of all 296 cohort members and two initial physician reviewers (M.L. and J.L.) each reviewed half (N=148) of the cohort. A final physician reviewer (D.J.M.) adjudicated any disagreements on adverse event occurrence between initial reviewers, per the IHI Global Trigger Tool method.² All reviewers received training on using the IHI Global Trigger Tool and practiced with standardized sample charts, following the training approach used by the tool developers.¹⁶ Reviewers determined whether each adverse event initially began before, during, or after the admission of interest. Analysis was restricted to adverse events which began during the index admission only as events that began prior to or after the admission may not be the result of exposure to Contact Precautions.

Our primary outcomes were noninfectious and infectious adverse event rates considered separately and the secondary study outcomes were preventable and severe noninfectious adverse events. Infectious adverse events were defined as infections that occurred in the hospital that were not present or incubating on admission while noninfectious adverse events that occurred in the hospital were all adverse events with infectious events excluded.

Examples of infectious adverse events include catheter-related bloodstream infections, ventilator-associated pneumonia, and urinary tract infections while noninfectious adverse events included events such as acute respiratory failure, acute renal failure, or oversedation. We rated adverse event severity using a 5-point Likert scale (minimal, clinically significant, serious, life-threatening, fatal) using a severity index modified from the National Coordinating Council for Medication Error Reporting and Prevention.^{2,17} Adverse events that were serious (e.g., organ dysfunction), life-threatening (death possible within a few hours without intervention), or fatal were classified as severe events. Similarly, preventability was measured on a 4-point Likert scale (definitely, probably, probably not, or definitely not preventable) as has been used previously.^{3,18,19} Preventability was determined based on whether the event was considered preventable by current knowledge, practice standards or technology.¹⁸ Finally, adverse events were also categorized by the primary physiological system affected (cardiovascular, respiratory, renal or endocrine, hematologic, gastrointestinal, neurologic, hospital-acquired infection, and surgical).³ Rates of adverse events were calculated as the number of a specific adverse event type divided by total person-time at risk (patient-specific hospital length of stay in days).

Statistical Analysis

Distribution of demographic variables, such as age or gender, by exposure to Contact Precautions was analyzed using t-tests for continuous variables and chi-square tests for categorical variables. An initial multivariable, scaled deviance Poisson regression model for noninfectious adverse events was constructed by including Contact Precautions exposure status and adjusting for the matching variable of admission service (grouped as oncology, general medicine, or surgery). More than one adverse event during an admission was allowed per patient but only the first eligible admission was reviewed for event occurrence (multiple admissions during the study period were not included). The model offset was the log of patient length of stay. An adjusted model for all noninfectious adverse events was constructed by adding covariates one at a time to the initial model in order of the greatest magnitude change produced in the log rate ratio of the Contact Precautions estimate until no meaningful change (less than 10%) occurred with the addition of new covariates. As no covariates meaningfully changed the coefficient, we included biologically plausible variables such as age and Charlson comorbidity score. Model building for preventable noninfectious adverse events followed the same approach as for the all noninfectious adverse events model. Models of severe and preventable adverse events were constructed using noninfectious adverse events only. Due to few severe noninfectious adverse events, we constructed a model for severe adverse events adjusted only for matching. For each physiological system, counts of adverse events by Contact Precautions exposure status were recorded and bivariate analysis was conducted using chi-square or Fisher's exact test, as appropriate. All analyses were conducted using SAS version 9.3 (SAS Institute, Cary, NC).

Power Calculation

Applying a previously reported frequency of adverse events among general medical inpatients (25 adverse events per 100 admissions)³ to the average length of stay among the current study's patients unexposed to Contact Precautions, the expected rate of adverse events among unexposed patients was 53.2 adverse events per 1000 patient-days. For a two-

sided test and $\alpha=0.05$, we had 84% power to detect an 80% increase in adverse event rate among patients on Contact Precautions compared to patients unexposed to Contact Precautions.

Results

Of the 296 patients in the cohort, 35.1% (104/296) experienced at least one adverse event (49 patients on Contact Precautions and 55 patients unexposed to Contact Precautions). There were 77.3 adverse events per 1000 patient-days within the entire cohort (62.8 events per 1000 patient-days among patients on Contact Precautions and 92.8 per 1000 patient-days among unexposed patients). Patients on Contact Precautions did not significantly differ from patients unexposed to Contact Precautions with respect to age, gender, Charlson comorbidity score (Table 1). However, patients on Contact Precautions were less likely to have at least some college education (37.8%) compared to patients unexposed to Contact Precautions (57.4%), $p<0.001$. In descriptive analysis, we observed a trend toward a fewer number of adverse events among patients on Contact Precautions for all physiological systems except respiratory, neurologic, and renal or endocrine (Table 2). We examined the trigger tool reviews of the thirteen patients with postoperative hemorrhage in depth as it was the event type driving a significant reduction in surgical adverse events among patients on Contact Precautions. There was an even distribution of patients experiencing postoperative hemorrhage by enrollment location (6 general medicine locations and 7 surgery or transplant locations). The majority of these adverse events were decreases in hemoglobin or hematocrit values during or immediately following surgery which required transfusion rather than harms caused during postoperative care.

In unadjusted analyses, Contact Precautions were significantly associated with a lower rate of noninfectious adverse events (rate ratio $[R_tR]$, 0.69; 95% confidence interval $[CI]$, 0.51–0.94; $p=0.02$) and a lower rate of infectious adverse events (rate ratio $[R_tR]$, 0.56; 95% confidence interval $[CI]$, 0.34–0.94; $p=0.03$). There was a trend toward fewer severe noninfectious adverse events (R_tR , 0.69; 95% CI, 0.46–1.03; $p=0.07$). Unadjusted results did not differ when adjusted for matching. Adjusted for gender, prior hospitalization, and Charlson comorbidity score, there was a significant 30% relative reduction in rate of noninfectious adverse events with exposure to Contact Precautions (R_tR , 0.70; 95% CI, 0.51–0.95; $p=0.02$; Table 3). There was no significant association between Contact Precautions and preventable noninfectious adverse events (R_tR , 0.85; 95% CI, 0.59–1.24 $p=0.41$) after adjusting for gender and Charlson comorbidity score. Males were 27% less likely to experience an adverse event compared to females (R_tR , 0.73; 95% CI, 0.54–0.99).

Discussion

In our prospective cohort study, we found significantly fewer noninfectious adverse events for patients exposed to Contact Precautions compared to patients unexposed to Contact Precautions. Our findings should be interpreted relative to past studies. Stelfox and colleagues conducted a prospective cohort study of adverse events and Contact Precautions in general medicine and congestive heart failure patients.⁹ They reported that patients on Contact Precautions experienced more than twice the rate of adverse events as patients

unexposed to Contact Precautions and seven times the rate of preventable adverse events. However, that study used a non-standard definition of adverse events which included abnormal laboratory values *without* requirement for harm (the majority of adverse events observed by Stelfox et al. belonged to this adverse event subtype) and likely had confounding by inappropriate matching. We identified an opposite effect.

More recent studies found a smaller impact of Contact Precautions. A case-crossover study by Karki et al. compared patients on Contact Precautions for vancomycin-resistant enterococci to earlier time periods when each patient was not on Contact Precautions. They observed no increase in adverse events during the periods of Contact Precautions use (R_tR 1.04; $p=0.70$).¹⁰ Another study using patients matched on admission diagnosis found no significant difference in the mean number of complications per patient when patients on Contact Precautions were compared to unexposed patients.²⁰ Similarly, the safety analysis for a cluster randomized trial of universal glove and gown use in intensive care units (universal use of Contact Precautions for all patient contact) found no significant association with adverse events, although there was a consistent trend towards fewer adverse events with universal Contact Precautions.¹⁶ This randomized trial used the same definition of adverse events and the same data collection tool, the IHI Global Trigger Tool, as in the current study.

This study has limitations. Patients exposed to Contact Precautions had lower educational attainment than patients unexposed to Contact Precautions, which may be an indicator of lower socioeconomic status among exposed patients. However, lower socioeconomic status is not known to affect a patient's risk of experiencing adverse events and would not explain the study findings. Chart reviews using the IHI Global Trigger Tool may fail to identify less severe adverse events. However, each patient chart was reviewed by two trained reviewers to help ensure all possible adverse events were identified. The IHI Global Trigger Tool has also been shown to identify more adverse events than other methods for measuring adverse events.^{15,21} We had limited ability to control for severity of illness because measures such as the Acute Physiology and Chronic Health Evaluation tool were unavailable for these patients outside of the intensive care setting. However, we did match study participants on admission service, as well as using the Charlson score to control for comorbidities. Furthermore, residual confounding from severity of illness would be expected to inflate risk estimates of the association between Contact Precautions and adverse events rather than result in a lower rate of adverse events as was observed in this study since patients indicated for Contact Precautions are more severely ill²² and more severely ill patients are more likely to experience adverse events.^{23,24}

The observed effect of Contact Precautions was unexpected and in the opposite direction of our hypothesized increase in risk. It remains unclear why hematologic and surgical adverse events, as well as noninfectious adverse events overall, might be lower in those patients on Contact Precautions. Patients on Contact Precautions appear to consistently receive fewer healthcare personnel visits.^{6,7} Fewer adverse events in this isolated group may reflect a protective effect from fewer healthcare personnel visits. Less healthcare personnel contact has been proposed to improve patient care and satisfaction.²⁵ Alternatively, the cognitive process required for considering room entry with Contact Precautions may have prompted

more thoughtful assessment of patient needs resulting in the observed reduction in noninfectious adverse events. Finally, unmeasured confounding may have been introduced through matching, if somehow patients on Contact Precautions were healthier than patients not on Contact Precautions. This could have occurred due to the increase of community-associated MRSA as an indication for Contact Precautions or if use of Contact Precautions caused patients to be more likely to have three day length of stay.

Our study is a sizeable matched cohort with 148 patients in each group and Contact Precautions exposure was known to precede occurrence of adverse events. Additionally, our study used a standard definition of adverse event² which aids in interpretation of our results and comparison with the existing literature. Finally, we identified adverse events using a standardized and validated data collection tool.^{14,19,26}

Hospital ward patients on Contact Precautions for antibiotic resistant organisms were less likely to experience noninfectious adverse events than patients unexposed to Contact Precautions and do not experience significant changes in preventable or severe noninfectious adverse events. Concerns that use of Contact Precautions may result in adverse events should not limit their implementation.

Acknowledgments

Financial support. A.D.H. received grant support from the National Institutes of Health (5K24AI079040-05). D.J.M has served as a consultant for Welch Allyn and is funded by the Department of Veterans Affairs (HSR&D CRE 12-307) and Agency for Healthcare Research on Quality (K08 HS18111).

References

1. Siegel J, Rhinehart E, Jackson M, Chiarello L. Health Care Infection Control Practices Committee. 2007 guideline for isolation precautions: preventing transmission of infectious agents in health care settings. *Am J Infect Control*. 2007; 35(10 Suppl 2):S65–164. [PubMed: 18068815]
2. Griffin, F.; Resar, R. Institute for Healthcare Improvement. [Accessed March 2014] IHI global trigger tool for measuring adverse events. Institute for Healthcare Improvement Innovation Series White Paper. 2009. <http://www.ihl.org/knowledge/pages/IHIWhitePapers/IHIGlobalTriggerToolWhitePaper.aspx>
3. Landrigan C, Parry G, Bones C, Hackbarth A, Goldmann D, Sharek P. Temporal trends in rates of patient harm resulting from medical care. *N Engl J Med*. 2010; 363(22):2124–2134. [PubMed: 21105794]
4. Goodman J, Villarreal P, Jones B. The social cost of adverse medical events, and what we can do about it. *Health Aff*. 2011; 30(4):590–595.
5. Kohn, LT.; Corrigan, JM.; Donaldson, MS., editors. Committee on Quality of Health Care in America, Institute of Medicine. To err is human: building a safer health system. Washington, DC: The National Academy Press; 2000. www.iom.edu/Reports/1999/to-err-is-human-building-a-safer-health-system.aspx [Accessed March 2014]
6. Kirkland KB, Weinstein JM. Adverse effects of contact isolation. *Lancet*. 1999; 354(9185):1177–1178. [PubMed: 10513715]
7. Morgan DJ, Pineles L, Shardell M, et al. The effect of contact precautions on healthcare worker activity in acute care hospitals. *Infect Control Hosp Epidemiol*. 2013; 34(1):69–73. [PubMed: 23221195]
8. Morgan DJ, Diekema DJ, Sepkowitz K, Perencevich EN. Adverse outcomes associated with contact precautions: a review of the literature. *Am J Infect Control*. 2009; 37(2):85–93. [PubMed: 19249637]

9. Stelfox H, Bates D, Redelmeier D. Safety of patients isolated for infection control. *JAMA*. 2003; 290(14):1899–1905. [PubMed: 14532319]
10. Karki S, Leder K, Cheng AC. Patients under contact precautions have an increased risk of injuries and medication errors: a retrospective cohort study. *Infect Control Hosp Epidemiol*. 2013; 34(10): 1118–1120. [PubMed: 24018935]
11. Zahar JR, Garrouste-Orgeas M, Vesin A, et al. Impact of contact isolation for multidrug-resistant organisms on the occurrence of medical errors and adverse events. *Intensive Care Med*. 2013; 39(12):2153–2160. [PubMed: 23995982]
12. Day H, Perencevich E, Harris A, et al. Depression, anxiety, and moods of hospitalized patients under contact precautions. *Infect Control Hosp Epidemiol*. 2013; 34(3):251–258. [PubMed: 23388359]
13. Mehrotra P, Croft L, Day HR, Perencevich EN, Pineles L, Harris AD, Weingart SN, Morgan DJ. Effects of contact precautions on patient perception of care and satisfaction: a prospective cohort study. *Infect Control Hosp Epidemiol*. 2013; 34(10):1087–1093. [PubMed: 24018926]
14. Naessens JM, O'Byrne TJ, Johnson MG, Vansuch MB, McGlone CM, Huddleston JM. Measuring hospital adverse events: Assessing inter-rater reliability and trigger performance of the global trigger tool. *Int J Qual Health Care*. 2010; 22(4):266–74.10.1093/intqhc/mzq026 [PubMed: 20534607]
15. Classen DC, Resar R, Griffin F, Federico F, et al. 'Global trigger tool' shows that adverse events in hospitals may be ten times greater than previously measured. *Health Aff*. 2011; 30(4):581–589.
16. Harris AD, Pineles L, Belton B, et al. Benefits of Universal Glove and Gown (BUGG) Investigators. Universal glove and gown use and acquisition of antibiotic-resistant bacteria in the ICU: a randomized trial. *JAMA*. 2013; 310(15):1571–1580. [PubMed: 24097234]
17. [Accessed March 2014] National Coordinating Council for Medication Error Reporting and Prevention (NCC MERP) Index for Categorizing Medication Errors. <http://www.nccmerp.org/medErrorCatIndex.html>. Published 2001
18. Rothschild JM, Landrigan CP, Cronin JW, et al. The Critical Care Safety Study: the incidence and nature of adverse events and serious medical errors in intensive care. *Crit Care Med*. 2005; 33(8): 1694–1700. [PubMed: 16096443]
19. Sharek PJ, Parry G, Goldmann D, et al. Performance characteristics of a methodology to quantify adverse events over time in hospitalized patients. *Health Serv Res*. 2011; 46(2):654–78.10.1111/j.1475-6773.2010.01156.x [PubMed: 20722749]
20. Masse V, Louis Valiquette, Boukhoudmi S, et al. Impact of methicillin resistant staphylococcus aureus contact isolation units on medical care. *PLoS One*. 2013; 8(2):e57057.10.1371/journal.pone.0057057 [PubMed: 23451144]
21. Naessens J, Campbell C, Huddleston J, et al. A comparison of hospital adverse events identified by three widely used detection methods. *Int J Qual Health Care*. 2009; 21(4):301–307.10.1093/intqhc/mzp027 [PubMed: 19617381]
22. Ho PL. Hong Kong Intensive Care Unit Antimicrobial Resistance Study (HK-ICARE) Group. Carriage of methicillin-resistant staphylococcus aureus, ceftazidime-resistant gram-negative bacilli, and vancomycin-resistant enterococci before and after intensive care unit admission. *Crit Care Med*. 2003; 31(4):1175–82.10.1097/01.CCM.0000059437.01924.97 [PubMed: 12682490]
23. Dequito AB, Mol PG, van Doormaal JE, et al. Preventable and non-preventable adverse drug events in hospitalized patients: a prospective chart review in the Netherlands. *Drug Saf*. 2011; 34(11):1089–1100. [PubMed: 21981436]
24. Baines RJ, Langelaan M, de Bruijne MC, et al. Changes in adverse event rates in hospitals over time: a longitudinal retrospective patient record review study. *BMJ Qual Saf*. 2013; 22(4):290–298.
25. Kolata, G. [Accessed February 18, 2015] Doctors strive to do less harm. *New York Times*. website. <http://www.nytimes.com/2015/02/18/health/doctors-strive-to-do-less-harm-by-inattentive-care.html>. Published February 17, 2015
26. Classen DC, Lloyd RC, Provost L, Griffin FA, Resar R. Development and evaluation of the Institute for Healthcare Improvement global trigger tool. *J Patient Saf*. 2008; 4(3):169–177.

Table 1

Demographic Characteristics for Patients on Contact Precautions vs. Patients Unexposed to Contact Precautions.

Characteristic	Contact Precautions		P
	Yes N=148	No N=148	
Age (years), mean $\pm$ SD	52.0 $\pm$ 13.8	52.3 $\pm$ 14.6	0.87
Male	86 (53.4)	75 (46.6)	0.20
Education (some college)	56 (37.8)	85 (57.4)	0.001
Married or living with partner	57 (38.5)	74 (50.0)	0.05
Minority	82 (55.4)	62 (41.9)	0.02
Charlson comorbidity score ²	73 (49.3)	63 (42.6)	0.24
Admission to ICU during hospitalization	8 (5.4)	14 (9.5)	0.18
Prior hospital stay in past 30 days	50 (58.8)	35 (41.2)	0.05
Enrollment location			-
General medicine	96	96	
Surgery/Transplant	34	34	
Oncology	18	18	
Length of hospital stay (days), median (IQR)	4.7 (3.3–7.1)	5.5 (3.7–8.1)	0.16

NOTE. Data are no. (%) of patients, unless otherwise indicated. SD, standard deviation; IQR, interquartile range; ICU, intensive care unit.

Table 2

Frequency of Specific Adverse Events in Patients on Contact Precautions vs. Patients Unexposed to Contact Precautions^a

Type of Adverse Event	Total Events	Contact Precautions		p ^b
		Yes N=148	No N=148	
Infectious adverse event	16	6	10	0.30
Central venous catheter-related bloodstream infection	3	2	1	
Ventilator-associated pneumonia	0	0	0	
Nosocomial pneumonia, not ventilator-related	1	1	0	
Urinary tract infection	3	0	3	
Surgical site infection	2	0	2	
<i>Clostridium difficile</i> colitis	5	3	2	
Other hospital-acquired infection ^c	2	0	2	
Cardiovascular system	9	3	6	0.50^d
Cardiac arrest	0	0	0	
Hypotension	6	3	3	
Arrhythmias or conduction abnormality	3	0	3	
Myocardial ischemia/infarction	0	0	0	
Respiratory system	8	4	4	1.00^d
Acute respiratory failure	1	0	1	
Pneumothorax	2	2	0	
Atelectasis	1	0	1	
Aspiration	1	1	0	
Pulmonary embolus	0	0	0	
Need for reintubation	0	0	0	
Renal or endocrine system	22	14	8	0.27
Fluid overload	3	2	1	
Acute renal failure	5	3	2	
Metabolic acidosis	0	0	0	
Hyperglycemia	5	3	2	
Hypoglycemia	8	5	3	
Hyperkalemia	0	0	0	
Other renal or endocrine event ^e	1	1	0	
Hematologic system	10	1	9	0.02
Hemorrhage	2	0	2	
Thromboembolic venous event	2	0	2	

Type of Adverse Event	Total Events	Contact Precautions		p ^b
		Yes N=148	No N=148	
Hematoma	2	0	2	
Other hematologic event ^f	4	1	3	
Gastrointestinal system	46	20	26	0.33
Nausea or vomiting	39	17	22	
Diarrhea	3	2	1	
Constipation	3	3	3	
Pancreatitis	0	0	0	
Ileus	0	0	0	
Other gastrointestinal event ^g	1	1	0	
Neurologic system	8	6	2	0.28^d
Oversedation	6	6	0	
Delirium or encephalopathy	2	0	2	
Seizure	0	0	0	
Stroke or intracerebral hemorrhage	0	0	0	
Inadequate analgesia	0	0	0	
Surgical event	19	3	16	0.002
Postoperative hemorrhage	13	1	12	
Postoperative hematoma	1	1	0	
Laceration or other organ injury	1	0	1	
Vascular injury	0	0	0	
Surgical anastomosis failure	0	0	0	
Wound dehiscence	0	0	0	
Failed procedure	0	0	0	
Unplanned return to surgery	1	1	0	
Other event ^h	3	0	3	
Other types of harm	24	11	13	0.67
Allergic reaction	11	5	6	
Pyrexia	1	1	0	
Fall	1	1	0	
Pressure ulcer	2	1	1	
Rash	1	1	0	
Catheter complication	2	1	1	
Other ⁱ	6	1	5	
All noninfectious events^j	146	62	84	0.01

Type of Adverse Event	Total Events	Contact Precautions		p ^b
		Yes N=148	No N=148	
Severe noninfectious events^{j, k}	47	20	27	0.27
Preventable noninfectious events^{j, l}	78	37	41	0.60

^a 162 total adverse events occurred (68 among patients on Contact Precautions; 94 among patients unexposed to Contact Precautions); events occurring in one physiologic system are mutually exclusive and do not appear elsewhere within other types of adverse events/harms unless otherwise indicated

^b Pearson chi-square test unless otherwise indicated

^c Other hospital-acquired infection events include: bronchitis; oral *Candida albicans*

^d Fisher's exact test

^e Other renal or endocrine events include: hyponatremia and hypovolemia due to diuresis

^f Other hematologic events include: chemotherapy-induced thrombocytopenia; chemotherapy-related decrease in white blood cell count; thrombophlebitis from IV requiring vein excision; postoperative thrombophlebitis

^g Other gastrointestinal events include: medication-related gastrointestinal upset

^h Other surgical events include: postoperative itching and insomnia; intraoperative anesthesia-induced increases in transaminases and bilirubin; acute on chronic pancreatitis secondary to ERCP

ⁱ Other type events include: graft versus host disease and nausea/vomiting; medication-induced restless leg; chemotherapy related mucositis, nausea/vomiting, and acute renal failure; itching due to pain medication; itching at patch site

^j Not included in total events count for the rest of the table as these events are not mutually exclusive of physiological system affected

^k Severe events include: adverse events which are serious (organ dysfunction); life-threatening (death possible without therapy within a few hours); death

^l Preventable events are adverse events considered probably or definitely preventable by current practice standards, knowledge, and/or technology

Table 3

Adjusted Rates of Noninfectious Adverse Events Among Patients on Contact Precautions vs. Patients Unexposed to Contact Precautions.

Type of adverse event	RtR (95% CI)	P
Noninfectious adverse events*		
Patients on Contact Precautions vs. unexposed to Contact Precautions	0.70 (0.51, 0.95)	0.02
Prior hospitalization in previous 30 days	1.22 (0.87, 1.70)	0.25
Charlson comorbidity score 2	1.04 (0.75, 1.45)	0.80
Male gender	0.73 (0.54, 0.99)	0.05
Preventable noninfectious adverse events*		
Patients on Contact Precautions vs. unexposed to Contact Precautions	0.85 (0.59, 1.24)	0.41
Male gender	0.67 (0.46, 0.98)	0.04
Charlson comorbidity score 2	0.89 (0.60, 1.33)	0.57

NOTE. *Adjusted for matching by unit of enrollment (surgery/transplant; oncology; general medicine). RtR, rate ratio; CI, confidence interval.