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Deconstructing the "July Effect" in Operative Outcomes: A National Study

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Abstract This study analyzes the relationship between hospital teaching status, failure to rescue, and time of year in select gastrointestinal operations. Procedure codes for laparoscopic cholecystectomy, colectomy, and pancreatectomy were queried from the Nationwide Inpatient Sample (2004–2011). Failure to rescue was defined as inpatient mortality when ≥1 complication. A total of 2,777,267 laparoscopic cholecystectomies, 2,519,903 colectomies, and 129,619 pancreatectomies were performed. Teaching hospitals had increased overall rates of failure to rescue compared to non-teaching hospitals, 10.0 vs. 9.5 % ($p = 0.0187$), particularly between May and August. There was greater inter-month variability in non-teaching hospitals amongst individual operations. On multivariable analysis, July was not predictive of increased odds of failure to rescue. Teaching status, hospital characteristics, and patient demographics were associated with increased odds of failure to rescue. Although teaching hospitals have a higher overall failure to rescue rate amongst the selected gastrointestinal operations, odds of failure to rescue are not increased in the month of July. Non-teaching hospitals tend to exhibit more monthly variation in failure to rescue rates, and hospital/patient demographics are predictive of failure to rescue. Further investigation targeted at identifying drivers of temporal variation is warranted to optimize patient outcomes.

Keywords Failure to rescue · July effect · Teaching hospitals

Introduction

Focus on healthcare quality and clinical outcomes has increased over the last few decades.[1] The medical community and general public are increasingly interested in factors that have an impact on postoperative outcomes.[2] In the past, mortality and morbidity were largely the focus of outcome analysis. A newer concept, failure to rescue (FTR), is now recognized in the context of surgical outcomes.[3–10] The risk associated with resident level care is now more closely scrutinized;[3,11–13] however, little is known regarding the impact this has on FTR. Recent literature has shown that resident involvement with laparoscopic gastric bypass has been associated with longer operative time and more postoperative complications.[3] In pancreaticoduodenectomy, patient outcomes improve as residents gain more experience.[11] Hospital stay and hospital charges also decrease over the academic year.[14] In trauma care, FTR rates are higher at teaching centers as compared to non-teaching centers.[4] This trend persists even after controlling for baseline characteristics between the two hospital groups.[4] Analysis of National Surgical Quality Improvement Program (NSQIP) data from primarily teaching hospitals also suggests increased morbidity and mortality in the early months of the academic year.[15] Others have found that resident participation may even be associated with lower rates of mortality[16,17] and FTR[7,17] despite increased postoperative morbidity. Though these results may not be entirely explained by resident participation in patient care, these

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studies raise questions at a time when many changes are occurring in surgical training.

General concern about the impact of resident care on patient outcomes has led to discussion of the "July effect." This is the concept that there is increased morbidity and mortality in the month of July, and it is attributable to the changeover to new house-staff.[18–20] Most studies on the topic provide single-institution data[18,21,22] or do not examine FTR.[15] National trends have been explored using large databases but predominantly address specific operations[6,18,22–25] (i.e., trauma operations,[22,23] pancreatectomy,[6] and coronary artery bypass[24]) or focus primarily on teaching hospitals.[15,26] This study aims to define the relationship between hospital teaching status and FTR as it relates to time of year in select common gastrointestinal procedures.

Methods

This is a retrospective review of data from the Nationwide Inpatient Sample (NIS). The NIS is an administrative database assembled by the Healthcare Cost and Utilization Project (HCUP), part of the Agency for Healthcare Research and Quality (AHRQ). Inpatient discharge ICD-9 diagnosis codes and ICD-9 procedure codes from 2004 to 2011 were queried. Discharge records were included in the analysis if an ICD-9 procedure code for pancreatectomy (52.51, 52.52, 52.53, 52.59, 52.6, 52.7), laparoscopic cholecystectomy (51.23, 51.24), or colectomy (17.32, 17.33, 45.72, 45.73, 17.34, 45.74, 17.35, 45.75, 17.36, 45.76, 45.8, 48.5,48.62, 48.63, 17.31, 17.39, 45.71, 45.79, 48.69) was utilized. These operations were chosen because of the varying complexity of operative technique and typical postoperative complications.

Patient characteristics collected include age, sex, race, payer type, and Elixhauser score, generated using the HCUP Comorbidity Software, version 3.7.[27] Admission characteristics collected include month of admission, urgency of admission (elective or non-elective), year, and procedure performed, as classified above. Hospital characteristics collected include teaching status, bed size (small, medium, or large), location (rural or urban), and region (Northeast, Midwest, South, or West) as defined by the NIS. Admission outcomes collected were inpatient morbidity and mortality. Morbidity was established using secondary diagnosis codes or procedure codes and included the following categories of diagnoses: infectious, respiratory, cardiac, wound complications, thromboembolic, perforation, and gastrointestinal bleeding or ulceration. FTR was defined as mortality in a patient with at least one complication, consistent with prior large database analysis of the topic.[10,28]

All statistical analyses were performed using the design-weighted survey procedures in SAS (version 9.3; SAS Institute, Cary, NC). For all analyses, a p value of <0.05 was considered statistically significant. All values reported were based on survey-weighted admissions. Continuous variables, age and Elixhauser score, were categorized to enhance clinical relevance. Race and payer categories with a small number of patients were collapsed into aggregate groups. Patient, admission, and hospital characteristics by FTR were compared using chi-square testing. A Cochran-Armitage trend test was used to assess monthly variation in FTR amongst teaching and non-teaching hospitals within patients who underwent pancreatectomy, laparoscopic cholecystectomy, and pancreatectomy separately. A fully adjusted multivariable logistic regression model was created using all available covariates. A subsequent multivariable regression model without pancreatectomy cases was performed to assess for possible case-mix due to the majority of pancreatectomies occurring at teaching hospitals. This study was deemed exempt by the Beth Israel Deaconess Medical Center Institutional Review Board.

Results

In the weighted NIS data, a total of 2,777,267 laparoscopic cholecystectomies were performed between 2004 and 2011. Of those, 1,008,961 (36.3 %) occurred at teaching institutions. A total of 2,519,903 colectomies were performed. Of those, 1,176,551 (46.7 %) occurred at teaching institutions. There were 129,618 pancreatectomies performed. Of those, 106,714 (82.3 %) occurred at teaching institutions (Table 1).

Patient, hospital, and admission characteristics are presented by hospital teaching status in Table 1. Overall, 129,113 (2.4 %) patients undergoing laparoscopic cholecystectomy, colectomy, or pancreatectomy died (Table 2). Complications occurred in 1,198,616 (22.1 %) cases (Table 2). FTR occurred in 116,498 (9.7 %) patients with complications. Analysis of FTR rates in teaching (10 %) versus non-teaching (9.5 %) hospitals revealed a statistically significant difference ($p=0.0187$). Divergence in FTR rates between teaching and non-teaching hospitals was particularly prominent between the months of May and August (Fig. 1). Chi-square trend tests of individual operations showed non-teaching hospitals had greater variance in monthly FTR rates as compared to teaching hospitals amongst the laparoscopic cholecystectomies (non-teaching $p=.00009$, teaching $p=0.1925$; Fig. 2a) and colectomies (non-teaching $p=0.0431$, teaching $p=0.2771$; Fig. 2b). For pancreatectomy, the trend test was not statistically significant although this may be a limitation of the trend test's inability to sense the cyclical nature of a calendar year (non-teaching $p=0.9663$, teaching $p=0.8102$). Grossly, there is a visible amount of variance amongst the non-teaching hospitals (Fig. 2c). There is also a statistically significant difference in the absolute rate of FTR amongst pancreatectomies between teaching and non-teaching hospitals ($p<0.0001$, Table 2)

Table 1 Patient, admission, and hospital characteristics by facility teaching status

	Non-teaching		Teaching		
	n	Weighted %	*n*	Weighted %	*p* value
Total	3,134,562	57.76	2,292,227	42.24	
Procedure	1,768,306	56.41	1,008,961	44.02	<0.0001
Lap. cholecystectomy	1,343,352	42.86	1,176,551	51.33	<0.0001
Colectomy					
Pancreatectomy	22,904	0.73	106,714	4.65	<0.0001
Elective	1,096,888	34.99	1,024,300	44.69	<0.0001
Transferred in	17,445	0.56	40,578	1.77	<0.0001
Bed size					0.0854
Small	325,917	10.40	289,196	12.61	
Medium	774,554	24.71	563,861	24.60	
Large	2,034,091	64.89	1,439,170	62.78	
Location					<0.0001
Rural	612,112	19.53	58,866	2.57	
Urban	2,522,450	80.47	2,233,360	97.43	
Age category					<0.0001
<40	605,197	19.31	454,502	19.83	
40–64	1,242,429	39.64	977,797	42.66	
≥65	1,286,935	41.06	859,927	37.51	
Sex					<0.0001
Male	1,221,062	38.95	915,645	39.95	
Female	1,913,413	61.04	1,376,556	60.05	
Race					<0.0001
White	1,928,087	61.51	1,273,396	55.55	
Black	182,043	5.81	220,661	0.63	
Other or missing	1,024,321	32.68	798,153	34.82	
Median ZIP income quartile					<0.0001
1st	781,570	24.93	552,230	24.09	
2nd	854,322	27.25	528,377	23.05	
3rd	768,235	24.51	570,043	24.87	
4th	664,066	21.19	592,222	25.84	
Elixhauser score					0.0107
0	787,857	25.13	583,267	25.45	
1	769,881	24.56	577,848	25.21	
2	648,742	20.70	478,557	20.88	
≥3	928,083	29.61	652,554	28.47	

In a fully adjusted, multivariate regression model of FTR, teaching status, urgency of admission, transfer from outside facility, year of resection, hospital bed size, hospital region, age, sex, race, zip code, median income quartile, payer, and Elixhauser score were significantly predictive of FTR odds (Table 3). The month of July, rural vs. urban hospital status, and race were not significantly predictive of FTR odds. A sensitivity analysis utilizing a separate fully adjusted model excluding pancreatectomy cases but including all other covariates found the results of the model to be unchanged (odds ratio of teaching vs. non-teaching hospital 1.185, CI 1.115, 1.260; Odds ratio of July vs. remainder of year 0.948, CI 0.877, 1.025).

Discussion

As the surgical community shifts more attention toward quality improvement and patient safety measures, studies that evaluate factors contributing to patient outcomes become more relevant. FTR is an important addition to outcomes assessment that aims to quantify timely and effective management of complications. We used the standard definition of

Table 2 Outcomes by facility teaching status

	Non-teaching		Teaching		
	n	Weighted %	*n*	Weighted %	*p*ss value
Disposition					<0.0001
Home	2,412,502	76.97	1,691,899	73.81	
Transferred to acute care hospital	31,168	0.99	9742	0.43	
Skilled nursing facility	304,022	9.70	220,373	9.61	
Home health care	316,507	10.10	310,389	13.81	
Death	69,662	2.22	59,451	2.59	
Complication	654,824	20.89	543,792	23.72	<0.0001
Lap. cholecystectomy	190,683	6.08	101,292	4.42	0.0004
Colectomy	454,512	14.50	405,170	17.68	0.1557
Pancreatectomy	9629	0.31	37,329	1.63	<0.0001
FTR	62,251	9.51	54,248	9.98	0.0187
Lap. cholecystectomy	7184	3.77	3730	3.68	0.6373
Colectomy	53,777	11.83	46,893	11.58	0.2926
Pancreatectomy	1289	13.39	3625	9.71	<0.0001

FTR, which despite being a surrogate marker for patient management, remains a distinguishing characteristic amongst high- and low-mortality hospitals.[6,25,29] This study demonstrates that overall, patients undergoing surgical management of the selected operations at non-teaching hospitals have lower rates of FTR compared to those treated at teaching hospitals (10.0 vs. 9.5 %). However, this may not be clinically significant and these data showcase that the relationship between FTR and teaching status is complex.

There does appear to be a larger difference in FTR rates from May to August. This trend suggests that a "July effect" may be present. However, it is unclear whether this divergence in FTR rates can be attributed to surgical house-staff transitions alone. Other system-based issues may contribute to this effect. Non-teaching hospitals had more variability in FTR month to month than teaching hospitals. Teaching status was found to be predictive of increased odds of FTR in our fully adjusted multivariable model; however, teaching status does not necessarily equate to resident participation. Several other hospital and patient demographics were also found to be predictive of FTR in our fully adjusted model. Further, there were increased odds of FTR in December. This is similar to findings by Englesbe et al. who demonstrated with the NSQIP database that morbidity and mortality were higher early in the academic year and in December at teaching hospitals.[15]

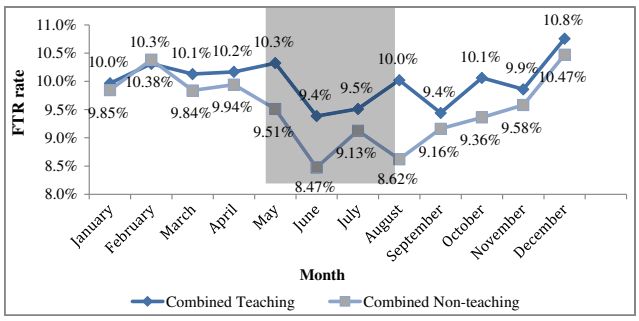

Fig. 1 Rate of failure to rescue in teaching versus non-teaching hospitals by admission month. Overall rate of FTR was higher at teaching hospitals (10.0 vs. 9.5 %, $p = 0.0187$). A large divergence in FTR rates appears to occur from May to August (*shaded area*)

Although house-staff turnover may explain some differences in FTR rates between teaching and non-teaching hospitals in the summer months, it does not explain why there is a climb in FTR rates between June and July in both teaching and non-teaching hospitals, a trend apparent in our data. A rise in FTR rates in December amongst teaching and non-teaching hospitals also lacks explanation. Intuitively, one would anticipate that inexperience of new house staff would be an issue in the summer, but this should not be the case in December. Current literature has identified a "weekend effect" associated with poor outcomes for general pediatric cases performed on weekends.[30]There is also description of a "reverse July effect," where resident burnout or decreased supervision leads to poorer outcomes later in the academic year.[31] The drivers of variations in care that occurs over the weekend or end of the academic year may be present around the summer and holiday time of year in both teaching and non-teaching hospitals. One additional cause may be due to vacations resulting in less available nursing, house staff, and/or attending surgeons. Increased sign-outs and handoffs due to limited coverage and a greater proportion of non-elective or emergent operations presenting to the hospital may also contribute to this effect. Our Cochran-Armitage trend test analysis also

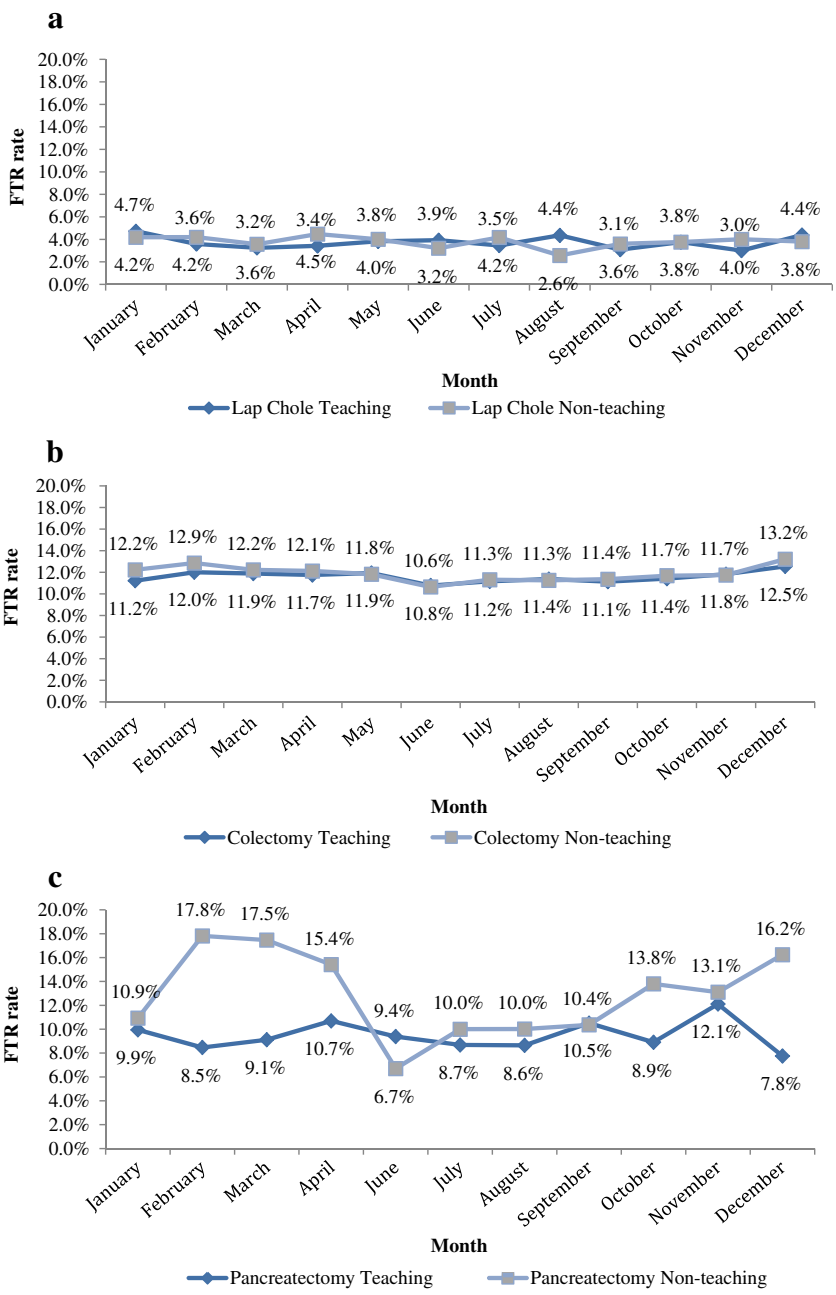

Fig. 2 **a–c** Rates of failure to rescue in teaching versus non-teaching hospitals by admission month in laparoscopic cholecystectomy (**a**), colectomy (**b**), and pancreatectomy (**c**). For laparoscopic cholecystectomy, Cochran-Armitage trend test analysis for variability was $p = 0.0009$ for non-teaching hospitals and $p = 0.1925$ for teaching hospitals. Amongst colectomies, Cochran-Armitage trend analysis was $p = 0.0431$ and $p = 0.2771$ for non-teaching and teaching hospitals, respectively. For pancreatectomies, Cochran-Armitage trend test analysis was $p = 0.9663$ and $p = 0.8102$ for non-teaching and teaching hospitals, respectively

showed that non-teaching hospitals appear to be more variable in FTR rates on a month-to-month basis. Together, these findings imply that additional system-based issues or disruptions might be present and that non-teaching hospitals are also susceptible to temporal variations.

It may also be possible that non-teaching hospitals are better at preventing FTR in less complex operations, and teaching hospitals excel at preventing FTR in complex operations. While teaching hospitals have more complications than non-teaching hospitals in pancreatectomy, the FTR rate is actually lower than FTR rates at teaching hospitals (Table 2 and Fig. 2c). Additionally, laparoscopic cholecystectomy did have lower complication rates amongst teaching hospitals ($p < 0.001$, Table 2). However, FTR rates following laparoscopic cholecystectomy were not statistically significant between teaching and non-teaching hospitals ($p = 0.6373$, Table 2). Notably, although only a small percentage of all patients were transferred to acute care facilities, this was more commonly the case with non-teaching hospitals (0.99 vs. 0.43 %, Table 2). This may because of fewer resources or limited capabilities for managing complex patients at non-teaching hospitals.

Table 3 Adjusted multivariable regression model of failure to rescue between teaching and non-teaching hospitals

	Odds ratio	95 % confidence limits	
Teaching vs. non-teaching hospital	1.193	1.123	1.267
July vs. remainder of year	0.945	0.875	1.021
Non-elective vs. elective procedure	2.088	1.979	2.203
Transfer from outside hospital vs. non-transfer	1.675	1.536	1.826
Years 2007–2009 vs. 2010–2011	1.162	1.103	1.224
Hospital bed size			
Small	–	–	–
Large	1.164	1.068	1.268
Medium	1.055	0.961	1.158
Rural vs. urban	0.940	0.863	1.024
Hospital region			
Midwest vs. Northeast	0.836	0.762	0.918
South vs. Northeast	0.895	0.824	0.973
West vs. Northeast	0.902	0.823	0.988
Age			
<40 years old	–	–	–
40–64 years old	2.247	1.941	2.602
≥65 years old	4.163	3.576	4.847
Male vs. female	1.102	1.056	1.150
Race			
White	–	–	–
Black	1.009	0.934	1.089
Other or missing	0.922	0.866	0.981
Median ZIP income quartile			
0–25th percentile	1.197	1.117	1.283
26th to 50th percentile (median)	1.130	1.055	1.209
51st to 75th percentile	1.086	1.017	1.159
76th to 100th percentile	–	–	–
Elixhauser score			
0	–	–	–
1	1.356	1.196	1.536
2	1.478	1.298	1.683
≥3	1.699	1.496	1.931

The strengths of this paper lie in the large patient population and diversity of general surgery operations included. To our knowledge, this is the largest analysis of FTR amongst general surgery patients and one of few papers available assessing temporal variations of FTR. Prior work on temporal variations such as the "July effect" using large databases has largely focused on morbidity and mortality alone[15,26] or focused on specific patient populations[6] which has limited the generalizability of results. We believe the results of this study are representative based on the comprehensive nature of the NIS, which provides a sample of inpatient discharges nationally. Coding was kept as inclusive as possible to account for most occurrences of FTR. However, it is possible that some complications, which do not fall under the aforementioned general complication categories available in NIS, may have been missed. Though not all surgical complications are accounted for in our dataset, we believe the selected procedures are most representative of both common and complex, potentially morbid operations.

There are several limitations to this study. First, the NIS database is limited only to discharge data without patient identifiers and, therefore, individual patients may be represented more than once and data about complications and deaths outside of the inpatient admission are not available. FTR outside of the inpatient setting is unaccounted for, which may be impacted differently by the covariates in our multivariate model. Race, for example, did not have statistically significant odds predictive of inpatient FTR despite being associated with poor outcomes in other studies.[32] Race may have stronger influence in the outpatient setting, which appears to be predisposed to

the effects of the social determinants of health, such as race. Details of clinical data that might serve to better inform the circumstances of postoperative complications or FTR, such as structural aspects of surgical care, are lacking. The NIS defines teaching hospitals as those with a 0.25 or higher of full-time equivalent interns and residents to non-nursing home beds. Though we are able to delineate teaching hospital status, it is unclear what the degree of resident or fellow involvement is on a case-by-case basis and the role supporting services play in managing patients with complications. Hospitals may also potentially be included in this analysis that do not have surgical residencies, but have enough residents in other specialties to exceed the 0.25 ratio to qualify as a teaching hospital.

As with any study that reviews administrative data, ours is subject to information bias. Analyzing all occurrences of failure to rescue as an aggregate is also difficult to interpret. The details leading from complication to death are simply not available in this large database. It is difficult to delineate the nuances of patient management within this dataset. Occurrences of death following a complication may be as protracted as a lengthy ICU hospital stay or lasting virtually seconds from a sudden myocardial infarction. Future large database studies may wish to focus on failure to rescue following specific complications, such as anastomotic leakage, so as to limit potential confounders and provide more interpretable data. Case mix between teaching and non-teaching hospitals may also have had unknown confounding effects. Finally, a limitation of the Cochran-Armitage trend test is the test's inability to analyze the cyclical nature of the calendar months when assessing variability. Despite these limitations, this study represents the most comprehensive analysis to date addressing FTR with regard to teaching status and month of care.

Results of this study have prompted us to begin a mixed-methods approach to understand how nursing, house staff, and attending personnel work toward rescuing patients from complications. We believe future projects such as this that aim to decipher the granular details of patient management may provide valuable insight in how we may improve our ability to rescue patients from complications.

Conclusion

The analysis of this national population of gastrointestinal surgical procedures identifies outcome disparities between patients undergoing surgery at teaching and non-teaching institutions. FTR rates are lower amongst patients treated at non-teaching institutions. This difference becomes more prominent between May and August, a time of transition for surgical trainees. However, non-teaching hospitals display great variance in FTR rates throughout the year and FTR rates at teaching and non-teaching hospitals appear to also increase in the winter. Further, patient demographics and hospital characteristics were also found to be predictive of FTR odds. Together, this implies that house staff turnover is not the only system-based phenomenon present. More studies are needed to identify the causes of this increased risk and temporal variation in order to optimize patient outcomes, particularly in at-risk settings and/or at-risk times of year.

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Compliance with Ethical Standards This study was deemed exempt by the Beth Israel Deaconess Medical Center Institutional Review Board.

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