Evaluation of a "meds-to-beds" program on 30-day hospital readmissions

Running Title Meds to beds and hospital readmissions

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Abstract

Purpose:

To evaluate readmissions among patients who received a medication discharge program compared to control patients who did not receive the program.

Methods:

This was a retrospective, observational cohort study during a 1-year period in a medium sized Midwestern health-system. The “meds-to-beds” program consisted of a pharmacist and/or technician delivering patient’s medications to bedside prior to discharge. When indicated, the pharmacist provided medication counseling, reviewed discharge medications, and provided an updated medication list to patients.

The intervention cohort was defined as all hospitalized patients eligible for and opting into the “meds-to-beds” program. The control cohort was defined as hospitalized patients eligible for the program who did not opt-in to receive it. Data were collected through both a retrospective chart review and an administrative claims data warehouse. The primary outcome was defined as any 30-day readmissions. Secondary outcomes were defined as any preventable 30-day readmissions using the Agency for Healthcare Research and Quality’s potentially avoidable hospitalization for ambulatory care sensitive conditions classification. Multivariable logistic regression models examined the odds of 30-day readmissions between the intervention and control groups.

Results:

Data were collected for 500 intervention and 1591 control patients. Both groups were similar with respect to age, gender, race, co-morbid conditions, and previous healthcare utilization. In the multivariable model, all-cause readmissions within 30 days were not significantly different between the intervention and control groups (OR=0.67; 95% CI: 0.42-1.07, p=0.09). The most common preventable readmissions were for pneumonia (43.2%), heart failure (18.9%), and dehydration (16.2%). In the multivariable model, patients in the intervention group were less likely to be readmitted for a preventable cause within 30-days than patients in the control group (OR=0.49; 95% CI: 0.28-0.89, p=0.02).

Conclusion:

This “meds-to-beds” program was not associated with a significant reduction in 30-day all cause readmissions but was associated with a reduction in 30-day preventable hospital readmissions.

Keywords

Transitions of care, pharmacy, medications, hospital readmission

Introduction

The Centers for Medicare & Medicaid Services (CMS) defines a transition of care as "the movement of a patient from one setting of care (hospital, ambulatory primary care practice, ambulatory specialty care practice, long-term care, home health, rehabilitation facility) to another"[1]. Transitions between these care settings, particularly from hospital to home, is a vulnerable period for patients resulting in high risk for adverse events and readmission. Approximately 27% of hospital readmissions within 30 days are considered preventable for many conditions.[2] These preventable readmissions have a significant economic effect on health systems, costing $566 million in penalties and affecting 50% of hospitals in 2019.[3] The Affordable Care Act established the Hospital Readmissions Reduction Program (HRRP) which has promulgated payment structures that penalize hospitals for preventable readmissions for specific diagnoses and procedures.[4] Effective programs for transitional care from hospital to home are needed to improve patient outcomes, avoid preventable readmissions, and reduce total healthcare costs.

Primary medication non-adherence is defined as the lack of filling the first or original prescription of medication. Within the hospital to home transitional care setting, primary non-adherence occurs upon hospital discharge where patients do not fill medications that were prescribed as part of their discharge plan. Studies suggest that up to 52% of patients encounter medication adherence related problems at discharge, which may be related to preventable hospital readmission.[5,6] Reasons for primary non-adherence include access to pharmacies, prescription costs, formulary restrictions, and patient understanding about the need for the newly prescribed medication.

One solution to overcome these barriers to primary non-adherence is a “meds-to-beds” prescription discharge program. These programs provide first fills of medications to patients within the hospital prior to discharge. They facilitate processing, insurance adjudications, prior authorization approvals, patient co-payments, and delivery of discharge medications to the patient at bedside. While these programs have become widespread among many hospital systems, little is known about their effectiveness on hospital readmissions. As a result, the purpose of this study was to determine the effect of a hospital prescription discharge (meds-to-beds) program on 30-day hospital readmissions.

Methods

Study Design and Setting

This was a retrospective cohort study to evaluate a meds-to-beds program. This study was approved by the Indiana University and Purdue University Indianapolis Institutional Review Board. The meds-to-bed program occurred in a tertiary care hospital, which is part of a larger statewide hospital system, located in a mid-sized Midwestern city. The hospital has 175 inpatient beds with an average daily census of 115-165 patients and has approximately 800 discharges each month.

Program Description

In May 2014, as part of a quality improvement initiative, the Department of Pharmacy Services implemented a bedside medication delivery (meds-to-beds). Patients received a specific days supply depending on how the discharge prescription was written by the

hospitalist. Typically, prescriptions were for 30-days supply or less as the patients' primary care physician or treating healthcare provider was responsible for renewing the prescription, if appropriate, during follow-up. Patients could choose to have all or part of their prescriptions filled at the time of discharge. This program was offered to all patients 7 days a week during normal business hours (8am-5:30pm).

The process for patient enrollment in the meds-to-beds program began at the time of admission. The medication history team, comprised of pharmacy technicians, completed a medication reconciliation on all newly admitted patients and provided the patients with an information card about the meds-to-beds program. If patients decided at the time of admission that they would like to utilize the meds-to-beds program, the medication history technician would document the patient's preferred pharmacy as the meds-to-beds pharmacy within the medical chart. This information served to notified the discharge team about the patient's preference for where prescriptions would be sent upon discharge. During the course of the hospital stay, a nurse or pharmacist could also remind patients about this program. Patients could opt-in or opt-out of the program at any time during their stay. A pharmacy technician would also approach all patients who had not opted-in or -out on the day of discharge to explain the program and determine interest. For any patient who opted-in, their prescription information (name, address, date of birth, insurance information, etc.) was sent to the meds-to-beds pharmacy to create a profile for processing prescriptions in the dispensing software. These patients also had their medical chart flagged to remind hospital personnel that orders for discharge prescriptions are to be sent to the meds-to-beds pharmacy for processing.

The meds-to-beds pharmacy was a closed-door satellite pharmacy embedded within the inpatient pharmacy. One FTE of pharmacy technician filled the discharge medications and resolved any financial or prescription processing barriers (such as unaffordable copays, insurance coverage, formulary and prior authorizations). Depending on the needs of the patient, other members of the care team were involved. For example, if the patient could not afford the medication, the technician would notify both the pharmacist and the physician and possibly involve social work. They would work together to identify cheaper alternatives or financial resources. Physicians would also be involved in medication changes required due to formulary or prior authorization issues.

Once filled and verified by a centralized pharmacist, the medications were delivered to the patient's bedside on the day of discharge. All unit-based pharmacists provided face-to-face counseling with the patient, reviewed all discharge medications including new and continuing medications for directions, communicated targeted drug-related information and gave the patient an updated active medication list. Targeted counseling for specific medications was used for therapies like anticoagulants, pain medications, antibiotics and other high risk medications. Documentation of the counseling as well as the updated active medication list was completed in the hospital's electronic medical record.

Study Cohort Selection

The study cohorts were determined from a retrospective report of adult patients who were discharged between January and December 2015 from one of four units (3 medical/surgical units and intensive care) and prescribed at least one new medication at

hospital discharge. Patients were excluded from the study if they were unable to opt-in to the program (intubation, mental status) or discharged to a step-down facility or hospice, or received medications from the VA. The intervention cohort was selected from patients who initially opted-in to the program by having a profile in the meds-to-beds pharmacy system and filling one or more prescriptions at discharge from this pharmacy. The control cohort was selected from patients who opted-out and did not have a profile in the meds-to-beds satellite pharmacy system. From the report, a stratified proportional random sample of 2200 patients were selected for the study using a 3:1 control-to- intervention ratio with a goal of 2000 patients (1500 control to 500 intervention). The 3:1 ratio was used as a sample of the proportion of all patients at the facility who opted-in to receive the meds-to-beds program during this time period. A 10% over-sampling was performed to account for incomplete data and post-chart review of exclusion criteria. Stratification of the sampling accounted for seasonality. For example, if 15% of all eligible patients were discharged in January, then 15% of patients who were randomly selected in both the control and intervention group were discharged in January (Figure 1).

Data collection

Data were collected using a combination of electronic chart review and administrative data provided by the healthcare system's data warehouse. The data warehouse includes data collected from electronic medical records documented during both inpatient and outpatient encounters and data generated from all clinical encounters within the network health system. Additional health care utilization and claims data from non-affiliated healthcare facilities were available through manual extraction using an

existing statewide Health Information Exchange which represents 117 hospitals within Indiana.[7]

Chart Review Data

Electronic chart review for all cohort subjects was performed by four study team members, who were not blinded to the study groups and were not involved in the meds to beds program. Data sources included the facility's electronic medical record, the facility's outpatient and meds-to-beds pharmacy records and Surescripts, which is a health care information exchange / third party administrator for prescription claims data from pharmacy benefits managers.[8] Prescription fill data were collected for all medications prescribed at admission and discharge, including drug name, dosage, dates of fill, quantity and days supply. Data were entered and stored securely in an online research data platform (REDcap).[9] All chart reviewers completed an in-person training conducted by a co-investigator familiar with the hospital electronic medical record system and data collection procedures. After completing 20 chart reviews, an assessment of inter-rater reliability was performed by having each reviewer complete 4 chart reviews previously completed by another reviewer. A kappa score of 0.93 was achieved across the 4 chart reviewers.

Health Care Facility Administrative Data

For all patients, the healthcare facility data warehouse extracted demographic and healthcare utilization files for 12 months before and 90 days after the index admission date. Index dates were defined as the first hospital admission within the 12 month study period where subjects opted-in or -out of the meds-to-beds program. Demographic files

included sex, age, race, and payer source(s). Healthcare utilization records included all inpatient and outpatient visits, tests and procedures performed and all primary and secondary diagnoses associated with these encounters. Additional data were collected about inpatient and emergency room visits to non-network facilities during the evaluation. Medical co-morbidities and discharge diagnoses were determined using the International Classification of Diseases, Ninth Revision (ICD-9) (January 2014-September 2015) and Tenth Revision (ICD-10) (September 2015-December 2016).[10,11] ICD-9 and ICD-10 codes were used to estimate medical comorbidities using the Elixhauser method.[12] ICD-9 and ICD-10 codes were also used to classify potentially avoidable adult rehospitalizations (also referred to as ambulatory care sensitive conditions) according to the Agency of Healthcare Research and Quality (AHRQ) definitions.[13,14] Administrative claims data were also used to calculate the LACE index (L: length of stay, A: acuity of admission, C: comorbidities, E: emergency department visits) for identification of patients at high risk for hospital readmission. The LACE score is a validated score used to predict unplanned readmissions or death within 30 days after discharge from a hospital to a community setting. The LACE score can range from 0-19, with a score of 5-9 considered moderate risk and a score >10 considered high risk for readmission.[15,16]

Outcomes

The primary outcome was defined as all-cause hospital readmission within 30 days. Planned secondary outcomes were potentially avoidable readmissions within 30 days defined by AHRQ,[13,14] and time to all-cause readmission (censored at 90 days).

Sample Size and Statistical Analyses

The sample size was estimated based on preliminary data suggesting a 9% difference in all-cause 30-day readmissions (18% for meds-to-beds vs. 27% for usual care). To achieve 90% power to detect a 9% difference between treatment arms using a two-sided Chi-square test at alpha level of 5%, a minimum of 500 patients would be needed in each group.

Baseline patient characteristics and outcome measures were summarized using descriptive statistics. The difference between groups was compared by using Student t test or Wilcoxon rank sum test for continuous variables and chi-square test for categorical variables. A multivariable logistic regression model examined the odds of 30-day readmission between intervention and control groups *a priori* adjusting for demographic variables (age, sex, and race). Important clinical covariates, including number of medications on admission, number of prior outpatient visits, prior inpatient visit, specific co-morbidities used in the Elixhauser method, and readmission risk score (LACE score) were added to the models if they were either significantly related to intervention/control status or to the outcome in univariate models using a 0.10 level of significance unless they were already used in the LACE score calculation. Note that the number of medications on admission was not correlated with LACE score or any of the specific comorbidities in the final models (Spearman's or point biserial correlations ranging from -0.032 to 0.027). Similar multivariable logistic regression models were used for the secondary outcome of 30-day preventable readmission. Firth's method was used to estimate the odds ratios in the 30-day preventable readmission variable because all subjects with the event were white (a situation called complete separation). Using standard maximum likelihood estimation methods will lead to biased parameter

estimates in this setting.[17] Time to all-cause readmission was modeled using Cox proportional hazards regression. A 5% significance level was used for all tests unless otherwise noted above. Analyses were performed using SAS version 9.4 (SAS Institute, Inc., Cary, NC).

Results

The cohort included 2091 patients (500 intervention and 1591 control). At index hospital admission, both groups were similar with respect to age, gender, race, co-morbid conditions, and previous healthcare utilization (Table 1). Readmission risk (LACE score) was moderate and higher in the intervention group compared to the control group (7 vs. 6, $p<0.001$).

The proportion of patients who were readmitted within 30 days was 5.2% (26/500) in the intervention group and 6.2% (99/1591) in the control group. In the multivariable model, all-cause readmissions within 30 days were not significantly difference between patients in the intervention and control groups (Table 2, OR=0.67; 95% CI: 0.42-1.07, p=0.09). Median time to readmission for those readmitted within 90 days was 24 days (range 3-88) in the control group and 22.5 days (range 3-85) in the intervention group. After controlling for baseline co-variates, time to readmission was not significantly different between the intervention and control groups (HR=0.73; 95% CI: 0.52-1.02, p= 0.07)

There were 84 potentially avoidable readmissions within 30 days. The most common preventable readmissions were for pneumonia (n=31, 36.9%), heart failure (n=17,

20.2%), and dehydration (n=11, 13.1%). Other important preventable readmissions include diabetes/diabetes complications (n=6, 7.1%), acute coronary syndromes (n=9, 10.7%), and chronic obstructive pulmonary disease/asthma (n=6, 7.1%). The proportion of patients who were readmitted within 30 days was 2.8% in the intervention group and 4.6% in the control group. In the multivariable model, patients in the intervention group were less likely to be readmitted within 30 days for a potentially avoidable cause than patients in the control group (Table 3, OR=0.49; 95% CI: 0.28-0.89, p=0.02).

Discussion

We found that all cause readmissions at 30 days were not significantly different between the control and intervention groups. There are few studies that have specifically evaluated meds-to-beds programs and the effect on hospital readmissions. Comer and colleagues found that a program similar to our intervention delivered at a large health system significantly reduced 30-day readmissions by 16% percent (OR 0.84; 95% CI 0.75-0.93) among a population of 6,057 intervention patients compared to 12,114 controls.[18] Similarly, Shaver and colleagues found a 67% decreased odds of all-cause 30-day readmissions (OR 0.33, 95% CI 0.22-0.48) in their transitions of care program that included meds-to-beds as a component of the intervention.[19] On the other hand, Lam and colleagues found that a meds-to-beds program was not independently associated with lower 30-day readmissions (AOR 0.91, 95% CI 0.79-1.04) in a large retrospective cohort study in a tertiary care hospital.[20] Our results are similar to Lam but in contrast to Comer and Shaver. One explanation for the contrasting findings may be

due to the relatively small rate of readmissions. In our population, we found an overall readmission rate of 6 percent and an absolute reduction of 1%. Similarly, in the Lam study, they had an absolute difference 2.2%. Our study was not powered to find this difference as our preliminary data suggested a 9% difference in readmission outcomes. Based on our results of a 1% difference (6.2% vs 5.2%), to achieve just 80% power at a 0.05 significance level using a Chi-square test, requires a sample size of 16,874 subjects (8,437 per group). In the Lam study, while power was not discussed, their intervention group was 2,252 and likely underpowered. The study by Comer et al, found an absolute reduction of 1.5% for 30-day readmissions among their population of 18,171 patients whereas the study by Shaver et al found a 10% reduction among their 1,219 patients.[18,19] The variability in the all cause readmission rates between these studies suggests that other population, geographic, or hospital specific characteristics may be important factors in determining the effectiveness of these programs. Our program evaluated patients with a moderate risk of readmission. The LACE score indicated both populations were only considered moderate risk of readmission with a median score of 6 and only 25% of the intervention population had a risk score of >10. Similarly, while the Lam study did not include a LACE score, the intervention group had significantly fewer prior hospitalizations and less comorbidities than the control group. On the other hand, in the study by Shaver et al, 55% of patients in the intervention group had a LACE score >10, suggesting higher overall risk for readmissions among their population.[19]

Our secondary outcome of preventable cause specific readmissions were significantly less in the meds-to-beds program compared to controls (OR=0.49; 95% CI: 0.28-0.89, p=0.02). The findings are policy and financially relevant as the CMS HRRP penalizes reimbursement for readmission related to six conditions (heart failure, acute coronary syndromes-acute myocardial infarction and coronary artery bypass, pneumonia, chronic obstructive pulmonary disease, and elective knee/hip replacement).[4] With the exception of knee/hip replacement, the other 5 conditions comprised 52/70 (74.3%) of the 30 day readmissions in the control group and 10/14 (71.4%) in the meds-to-beds program. Similar findings among HRRP populations support our results. In a systematic review of transitions of care (TOC) studies and pharmacy personnel, 9 studies either favored the TOC intervention or showed a positive trend toward lowering 30 day readmissions among HRRP populations.[21] Four studies did not show a difference and there were no studies that favored the control group. In the program evaluated by Shaver et. al, patient eligibility was based on discharge diagnoses for variety of cardiac-related conditions including those for HRRP conditions.[19] Their results found cause specific readmission for cardiac related conditions decreased by 62% (OR 0.38, 95% CI 0.18-0.82; p=0.008). As payment models continue to shift toward performed-based reimbursement, a meds-to-beds program can be one TOC intervention to improve outcomes. These programs also have the benefit of increasing revenue for the institutions through prescription reimbursement while simultaneously improving patient satisfaction, an important measure for hospital quality ratings.[18]

Furthermore, a meds-to-beds program should be one component of a broader and potentially more effective TOC program. Not only does a meds-to-beds program facilitate overcoming obstacles related to primary medication adherence, the program also creates opportunities for more effective pharmacy-based interventions to improve patient medication counseling and medication reconciliation. In a meta analyses of pharmacy programs for TOC, the odds of all-cause 30-day readmission was reduced by 32% (OR = 0.68; 95% CI = 0.61, 0.75) for pharmacy-supported TOC interventions compared with usual care.[21] The paper's findings supported that medication management strategies and incorporation of combination of pharmacy services were paramount to improve 30-day readmissions.

Our findings should be interpreted with some limitations. We did not collect data on other ongoing TOC activities, including pharmacy specific medication counseling and reconciliation. These activities were widespread during the time of our meds-to-beds program evaluation. The activities were not provided specifically to our intervention cohort and likely were equally provided to the control cohort. However, we cannot rule-out the possibility that more TOC pharmacy services were provided to the intervention group. Furthermore, patients in the program opted-in; creating the likely potential for selection bias and confounding. Our analyses controlled for key variables between groups, but there may be other variables that were not collected that could affect the decision to offer the program among technicians or the decision to opt-in among the patients in our study. Additionally, our data collection process may not have captured all readmissions as patients could have been readmitted to other healthcare facilities that

were not part of our data sharing agreement. The binary outcome of readmission also does not account for the burden of the readmission (e.g., the length and intensity of it). Theoretically, the control group could have had a greater number of readmissions, but incurred less hospital days if the readmissions were quite brief (indicating that they were likely not serious). Our study was conducted at a single site and may not be generalizable to other healthcare systems and geographic locations. Our study included a broad population, but the relatively low LACE scores and limited length of stay suggest a population that was not very ill. Therefore, it is unknown if our findings would be similar among other patient populations with more severe illness. Finally, while our study was conducted in a manner to collect data on primary non-adherence, these data are not presented within this paper. Future analyses will examine the effect of the beds to bed program on primary non-adherence as well as examine the classes of medications that were prescribed but not filled at discharge and their association with 30-day readmissions or emergency department visits.

Conclusion

This “meds-to-beds” program was not associated with a significant reduction in 30-day all cause readmissions but was associated with a reduction in 30-day preventable hospital readmissions. Within health systems, cost-effective transitions of care interventions are needed and must largely target reducing avoidable hospitalizations. Future studies should determine the cost-effectiveness of this meds-to-beds program and evaluate the effect of the program on primary non-adherence.

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Table 1: Baseline characteristics (n=2091)

Characteristic			Treatment	
Variable		Overall (n=2091)	Control (n=1591)	Intervention (n=500)
Race, no. (%)	White	2007 (96%)	1522 (96%)	485 (97%)
	Non-white	72 (3%)	59 (3%)	13 (3%)
	Unknown	12 (1%)	10 (<1%)	2 (<1%)
Sex, no. (%)	Female	977 (47%)	749 (47%)	228 (46%)
	Male	1114 (53%)	842 (53%)	272 (54%)
Ethnicity, no. (%)	Hispanic/Latino	57 (3%)	40 (3%)	17 (3%)
	Not Hispanic/Latino	2009 (96%)	1532 (96%)	477 (95%)
	Unknown	25 (1%)	19 (1%)	6 (1%)
Insurance type, no. (%)	Medicare	1040 (50%)	800 (50%)	240 (48%)
	Medicaid	201 (10%)	152 (10%)	49 (10%)
	Other government	91 (4%)	70 (4%)	21 (4%)
	Commercial	576 (28%)	434 (27%)	142 (28%)
	Self pay	164 (8%)	123 (8%)	41 (8%)
	Other	19 (1%)	12 (1%)	7 (1%)
Age, mean (±SD)		62.6 (18.5)	62.8 (18.4)	61.9 (18.7)
Comorbidities*, median (IQR)		3 (1-4)	3 (1-4)	2 (1-4)
# of previous ER visits^, median (IQR)		0 (0-1)	0 (0-1)	0 (0-1)
# of previous Inpatient visits, median (IQR)		0 (0-0)	0 (0-0)	0 (0-0)
Length of stay^, median (IQR)		2 (1-4)	2 (1-4)	3 (1-5)
# of previous Outpatient visits, median (IQR)		1 (0-4)	1 (0-4)	1 (0-4)
# of medications on admission, median (IQR)		8 (4-12)	8 (4-12)	8 (4-12)
LACE Score^, median (IQR)		6 (4-9)	6 (4-9)	7 (5-10)

*Comorbidities were estimated using the Elixhauser comorbidity index. The numbers represent the median and range for the total number of comorbidities. Of the 30 conditions, arrhythmias, ulcers, and neurological conditions were significantly different between groups.

^p-values are significantly different between groups

Table 2. Logistic Regression Model on 30-day All-cause Readmission

Effect	OR	95% Confidence Limits		P-value
Intervention vs Control	0.669	0.419	1.068	0.0919
Age	0.995	0.985	1.005	0.3582
Female vs Male	1.084	0.744	1.578	0.6754
Non-white vs White	0.247	0.034	1.816	0.1693
LACE Score	1.195	1.124	1.271	<.0001
# of medications on admission	1.014	0.984	1.045	0.3694
# of previous outpatient visits	1.024	0.995	1.054	0.1066
Prior inpatient visit, No vs Yes	0.843	0.546	1.302	0.4419
Comorbid Conditions				
Arrhythmia, No vs Yes	0.712	0.432	1.172	0.1814
Anemia, No vs Yes	0.740	0.432	1.267	0.2723
FEN*, No vs Yes	0.677	0.345	1.33	0.2574
Neurologic Disorder, No vs Yes	1.549	0.935	2.566	0.0896
Ulcer, No vs Yes	0.261	0.141	0.483	<.0001

*Fluids, Electrolytes, Nutrition

Table 3. Logistic Regression Model on 30-day Avoidable Readmission

Effect	OR	95% Confidence Limits		P-value
Intervention vs Control	0.494	0.276	0.885	0.0177
Age	0.994	0.983	1.006	0.3299
Female vs Male	1.275	0.824	1.974	0.2757
Non-white vs White	0.189	0.012	2.949	0.2348
LACE Score	1.192	1.110	1.280	<.0001
# of medications on admission	1.020	0.985	1.055	0.2644
# of previous outpatient visits	1.021	0.988	1.056	0.2146
Prior inpatient visits, No vs Yes	0.799	0.484	1.321	0.3817
Comorbid Conditions				
Arrhythmia, No vs Yes No vs Yes	1.076	0.564	2.054	0.8238
Anemia, No vs Yes	0.975	0.501	1.894	0.9394
FEN*, No vs Yes	0.479	0.234	0.980	0.0439
Ulcer No vs Yes	0.295	0.146	0.594	0.0006
Substance Abuse, No vs Yes	0.386	0.125	1.189	0.0973
Thyroid, No vs Yes	0.789	0.478	1.302	0.3545
Neurologic Disorder, No vs Yes	1.558	0.865	2.808	0.1400

*Fluids, Electrolytes, Nutrition

Figure 1. Flow Diagram of Study Cohorts