

Reliable Adherence to a COPD Care Bundle Mitigates System-Level Failures and Reduces COPD Readmissions: A System Redesign Using Improvement Science

(On-line supplement)

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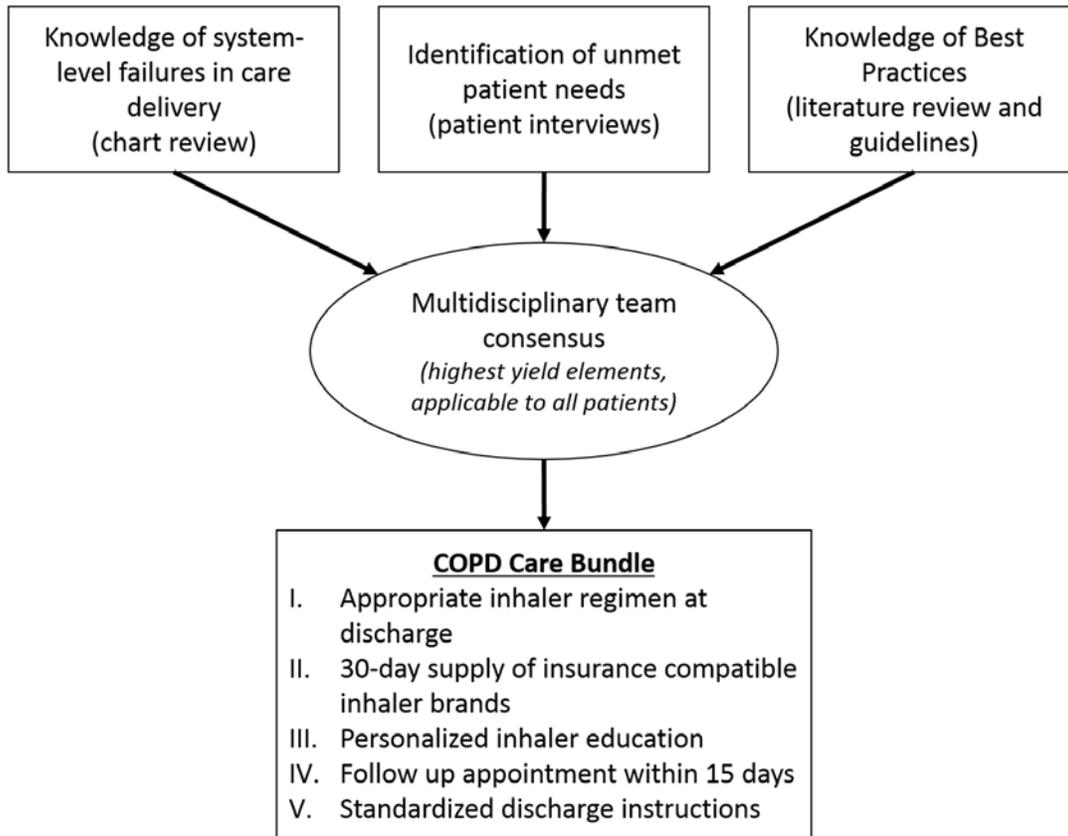
eTable 1: Definition and ICD codes used for COPD exacerbation index admission
<p>COPD Index admission: Patients with a primary diagnosis of COPD or a primary diagnosis of respiratory failure with COPD as secondary diagnosis were identified as index cases using ICD codes according to CMS guidelines</p>
<p>ICD Codes: ICD-9 codes were used from 8/2013 to 9/2015. ICD-10 codes used from 8/2015 to 7/2016, with 2-month of overlap from 8-9/2015. This change was due to switch from ICD-9 to ICD-10 codes in Oct 2015 throughout the U.S.</p>
<p>ICD-9 codes: 491.21, 491.22, 491.8, 491.9, 492.8, 493.20, 493.21, 493.22, 496, 518.81, 518.82, 518.84, 799.1</p>
<p>ICD-10 codes: J40, J41.0, J41.1, J41.8, J42, J43.0, J43.1, J43.2, J43.8, J43.9, J44.0, J44.1, J44.9, J47.1, J47.9, J96.0, J96.9, J80, J96.2, J20.0, J20.1, J20.3, J20.4, J20.5, J20.6, J20.7, J20.8, J20.9, R09.2</p>
<p>ICD: International classification of diseases, COPD: chronic obstructive pulmonary disease, CMS: Center for Medicare and Medicaid Services</p>

eTABLE 2: Summary of Plan-Do-Study-Act (PDSA) cycles for interventions		
Interventions	Plan-Do-Study-Act cycles summary	Outcome, challenges and final act
Process: Reliable identification of patient and timely activation of COPD care bundle		
<i>Role of bedside nurse in identifying COPD patients</i> (3 PDSAs)	Developed EMR report to identify COPD patients in hospital. Asked unit nurses to run report daily and notify physicians if COPD bundle was not ordered on an appropriate patient. Initial testing on 1 unit. Scaled up to 3 Medicine units	Process was easy but an added task to nurses' work flow. Could not be performed consistently. Did not add value when other interventions were tested (as below). Process abandoned
<i>EMR best practice alert (BPA) to prompt use of COPD care bundle order set</i> (2 PDSAs) LOR 2	Once appropriate roles of each team were identified and EMR orders were built for bundle activation, we developed an EMR COPD care bundle BPA to prompt providers for use. Initial testing was on 2 teams. Scaled up to all medical services.	BPA was accurate in identifying cases (diagnosis of COPD, active order for nebulizer bronchodilators and systemic steroids) in appropriate setting (floor units) for appropriate providers (medicine providers only). Reliability of early bundle activation increased to > 90%. Occasional failures occur with new providers but easily mitigated with training. Process implemented
<i>Physician training in COPD bundle use</i> (4 PDSAs) LOR 1	During early testing, bundle trigger was supported by personal messages on EMR or emails to physicians for bundle activation. Once EMR order set and BPA were finalized and implemented, we started training physicians in the correct use of the bundle. Testing include email communication with simplified bundle use instructions for first time users and a 4-slide review at monthly orientation for house staff working on medicine floors	With training via email, 1 out of 4 first time users required additional personal contact via email and phone calls for correct and timely use of bundle orders. A "champion" among hospitalist faculty is responsible for training all new hires. With slides incorporated into existing monthly resident orientation session coupled with BPA, timely bundle activation has level 2 reliability. Process implemented
Process: Early identification of insurance compatible inhaler brands		
<i>Communication between in-patient and out-patient pharmacy and discharge medication reconciliation</i> (8 PDSAs) LOR 2	Initial testing used EMR communication and telephone communication to identify what information exchange is needed. In later testing all essential information was made part of a standardized EMR order. The time required to complete the process was tracked from pharmacist feedback. Process was scaled up to all pharmacists, discharge clerks, and all days of the week.	Testing helped identify unanticipated failure modes, most of which were mitigated by re-design or clarification in EMR orders. EMR wording for the COPD order set was revised to comply with state law requirements for pharmacists as transcribers of medication orders. Physicians identify the classes of inhalers (LABA/ICS, LAMA, SABA) that are required at discharge and the pharmacy process identifies brands that are compatible with a patient's insurance, updates the discharge medications list, and communicates this information to all providers via a templated EMR note. Process implemented
Process: Inhaler education		
<i>Respiratory therapists (RTs) to deliver bedside inhaler education for discharge inhaler brands</i> (5 PDSAs) LOR 1 with added redundancy	Individualized handouts for each inhaler brand were created with explanatory illustrations and grade 6 readability. Further modifications were made based on patient and RT feedback. During early testing, we recognized the need for 'inhalers in hand' for education. Inhaler kits were created, which included handouts, practice inhalers of each brand, and step-by-step instructions for teaching (including teach-back). Activation of the COPD bundle initiated patient specific inhaler education by RT based upon the insurance compatible medications identified by pharmacy and specified	Initially, RT required 15 min for education sessions. After practice, each session lasted approximately 8-10 min for most patients. Patient found these sessions and handouts very useful. Many had incorrect inhaler use technique and front-line RT staff felt "they made a difference". A training module was developed once testing was completed. All RT staff (104 RTs) were trained in this process. A RT "champion" was identified to measure compliance with the process, train all new hires, and maintain inhaler education kits. Process implemented

	in their EMR note discussed above. An EMR re-trigger (redundancy) was later added after pharmacy note completion to increase reliability. Scaled up to all RT staff.	
Process: providing a 30-day inhaler supply		
<i>Preparation and delivery of 30-day insurance compatible inhaler supply before discharge</i> (3 PDSAs) LOR 1	Early identification of discharge inhaler brands allowed lead time for out-patient pharmacy to prepare and dispense 30-day supply. Testing started with weekday, day time only and was scaled up to include all days, all discharge pharmacy clerks and pharmacists.	The process was made possible due to the lead time available for pharmacy to investigate insurance compatibility and arrange copays/ subsidies. Few exceptions were identified (patient prefers other pharmacy, care at VA hospital, out of state Medicaid). If a patient had refilled medications within the prior 2 weeks then a new supply was not provided. Process implemented
Process: Use of standardized discharge instructions		
<i>Standardized discharge instructions template for physicians</i> (3 PDSAs)	Developed a standardized discharge instruction template in EMR with grade 6 readability. Modifications were made to content and language based upon patient feedback. Physicians were educated and trained in using standardized discharge instructions at time of discharge. Test was scaled up to include all medicine services.	The template was easy to use, easy to understand for patients and rarely needed any edits by physicians. The process was not reliable. Many times physicians would either forget or have competing needs to write different instructions. Physicians who used it were more likely to use it again and found it to be easy and efficient. Process is available for use as needed
<i>Use of "My COPD Care" worksheet for COPD care education</i> (2 PDSAs) LOR 1 with added redundancy	Developed "My COPD Care" as an education tool using patient-centered design principles (Fig S2). This tool includes plan of care during hospital stay, discharge instructions and preparation for clinic follow-up. RT's incorporated it into their inhaler education process. Modifications were made based on feedback from patients and RTs.	The process was well received by patients, RTs and physicians. All felt that it added value to care. The testing was quickly up-scaled as the inhaler education process was already in place. All RT staff were trained to use this worksheet with patients. Process implemented
Process: Arranging follow up clinic appointments within 15 days of discharge		
<i>Assessment by care-coordinator (CC) and follow-up arrangement</i> (3 PDSAs) LOR 1	Initial testing was to assess feasibility of face-to-face evaluation of all COPD admits by CC. Clinic appointments were arranged by CC with the primary care provider within 15 days of discharge. This process was a modification of an existing process that CC use for high risk patients only. Additional out-patient resources were not added (eg: extra clinics). Process was scaled up to all CC on all medicine teams.	CC do not use EMR for communications. They relied on primary admission diagnosis and physician communication for orders. In COPD bundle order set, physicians are reminded to call their CC for communications. The reliability has been sustained at >90%; however longer monitoring will be done to ensure sustainability. For 1 in 20 discharges, CC have difficulty in finding an open appointment within 15 days. Process implemented with close monitoring
Process: Check list review of COPD bundle components before discharge		
<i>Bed side nurse to perform a discharge checklist with COPD patients</i> 3 PDSAs	Designed a discharge check-list and modified it based upon initial testing to include a list of items and "Action to be taken" if an item was missing. Check list was performed at time of discharge and plan was to incorporate final check list in EMR if implemented. Scaled up to 3 units.	After modifications, the check-list was self-explanatory and easy to complete by bedside nurses. It was difficult for nurses to correctly identify patients who needed the checklist because COPD patients were randomly distributed throughout the medical wards. They were not a frequent occurrence per unit so learning was slow and the process was unreliable. As other processes became reliable, this did not add value. Process abandoned
LOR: level of reliability. Number of actions that achieve the intended result / total number of actions LOR 1: success rate 90%, LOR 2: success rate 95-99%		

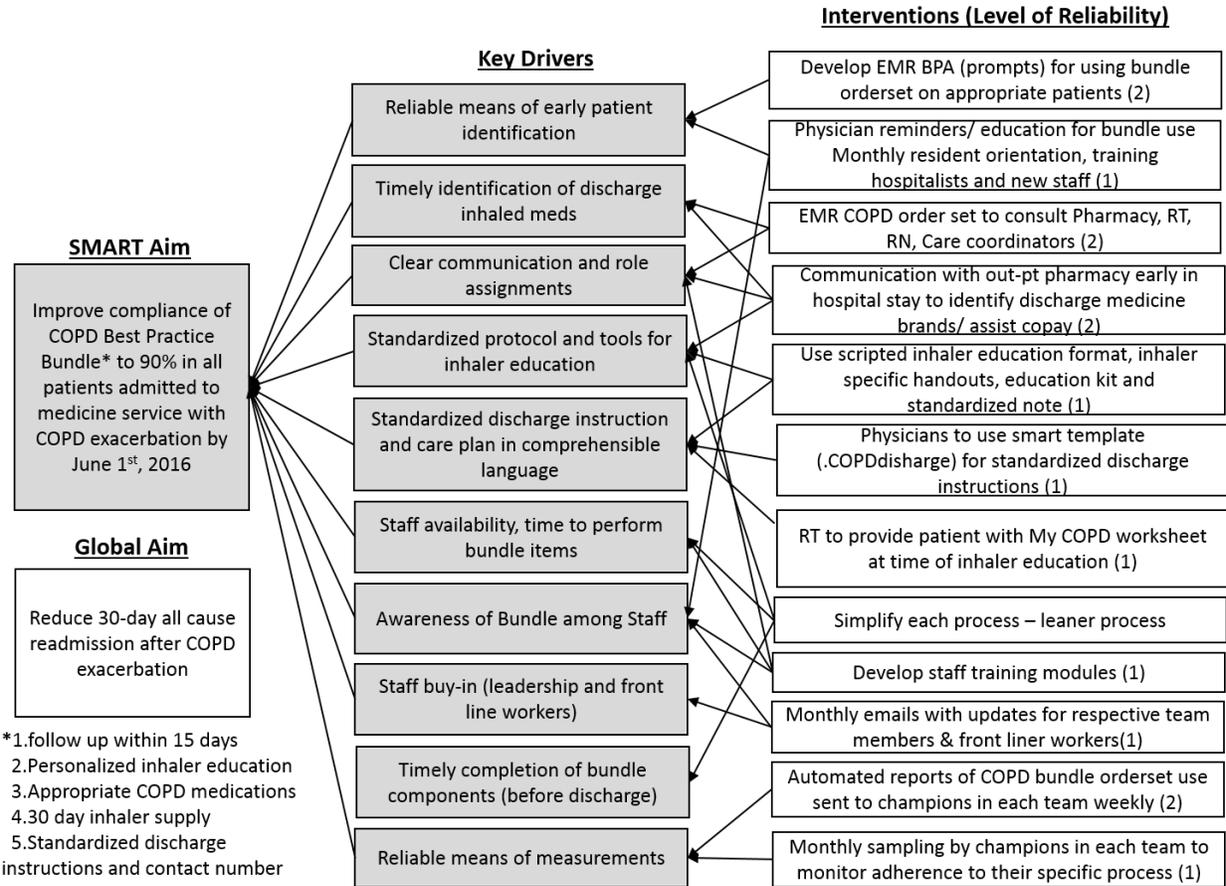
COPD: chronic obstructive pulmonary disease, EMR: electronic medical record, BPA: best practice alert, LABA: long acting beta adrenergic agonist, ICS: inhaled corticosteroid, LAMA: long acting muscarinic antagonist, RT: respiratory therapist, VA: Veterans Affairs, CC: care coordinator,

eTable 3: Effect of adherence to bundle components on 30-day readmissions for patients discharged to home (Oct 2015 to July 2016)			
	All bundle components received	Missed one bundle component	Missed \geq 2 bundle components
Number of Encounters	91	56	57
Total bundle components applicable [^]	443	264	277
Total bundle components completed	443	208	144
Bundle component Adherence (%)	100	79	52
All-cause Readmissions	10	7	15
Readmission rate	10.98*	12.5**	26.31
COPD related Readmissions	7	3	9
COPD related readmission rate	7.69	5.35	15.78
<p>* Chi-square test. p-value 0.015 in comparison to "Missed \geq 2 bundle components"</p> <p>** Chi-square test. p-value 0.06 in comparison to "Missed \geq 2 bundle components"</p> <p>[^] Occasionally one component may not be applicable for a patient (examples: patient preference of pharmacy, out of state Medicare requires in-state pharmacy for refills, difficulty in comprehending inhaler education due to developmental delay or dementia, etc)</p>			



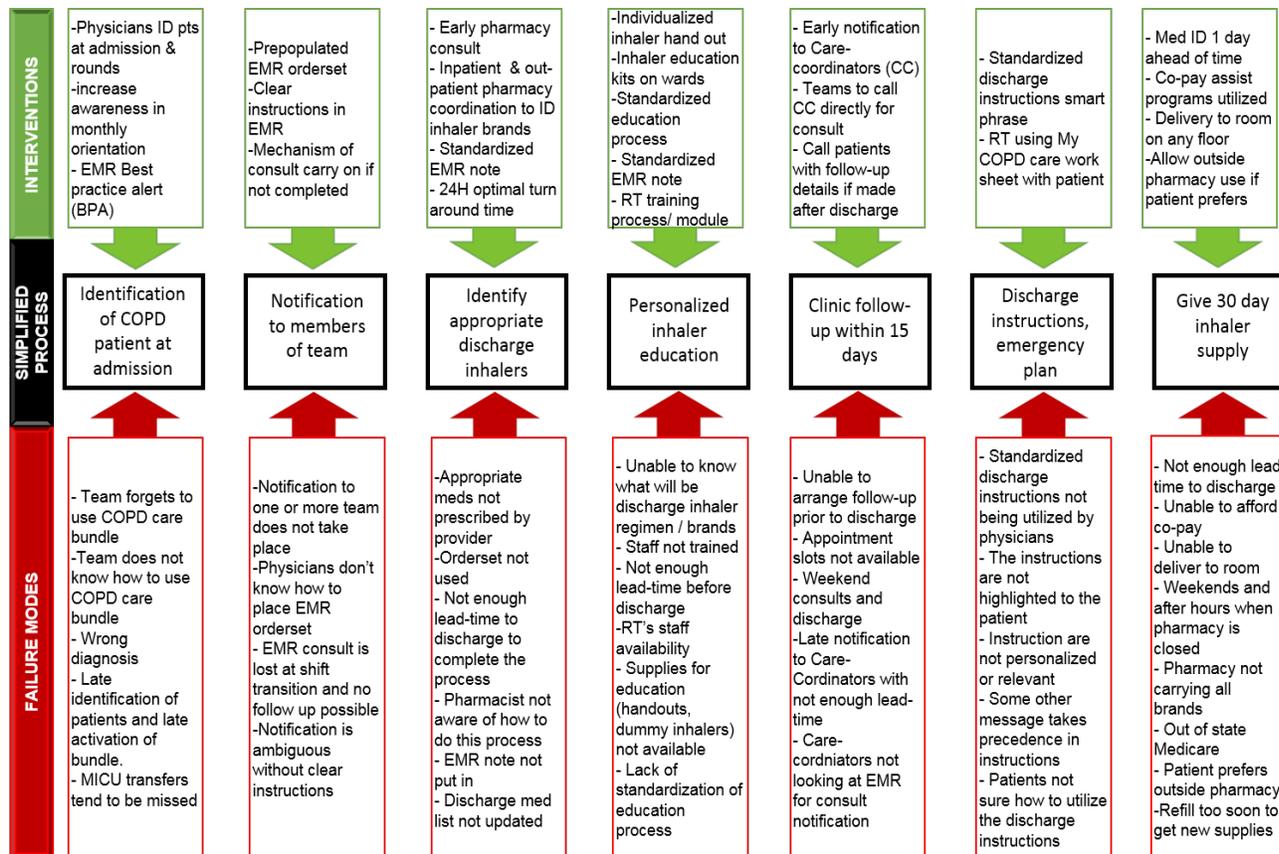
eFigure 1: Methodology for developing the COPD care bundle. System failures, unmet patient needs, and literature review for best practices helped the multidisciplinary team identify high yield components for the 5-element COPD care bundle. The team consisted of hospitalists, pulmonologist, respiratory therapist, pharmacists, care-coordinators and nurses.

COPD: chronic obstructive pulmonary disease



eFigure 2: Key Driver Diagram

COPD: chronic obstructive pulmonary disease, EMR: Electronic Medical Record, BPA: best-practice alert, RT: respiratory therapist, RN: registered nurse



eFigure 3: Simplified Failure Mode Effects Analysis (FMEA) for COPD care bundle delivery. The FMEA was updated as new failures were observed by learning through testing. Interventions were designed to mitigate failures in each process.

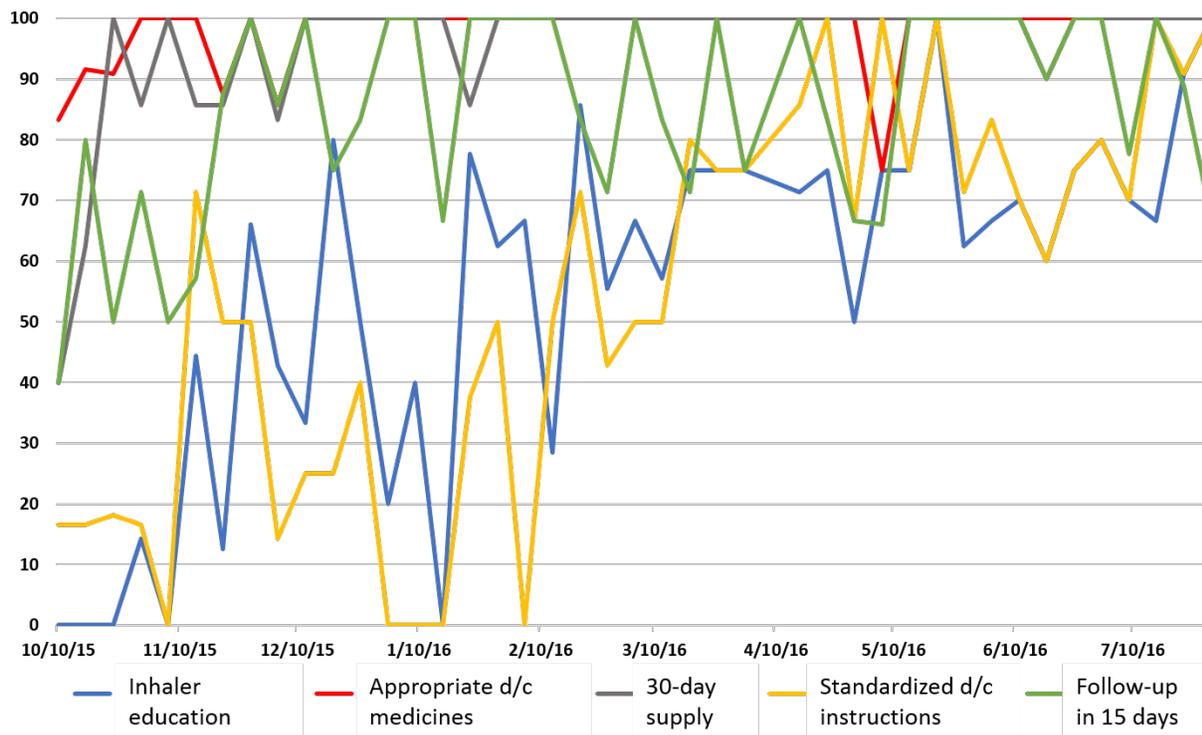
COPD: chronic obstructive pulmonary disease, ID: identify, Pt: patients, EMR: Electronic Medical Record, BPA: best-practice alert, RT: respiratory therapist, MICU: Medical intensive care unit, Med: medicine, CC: care-coordinator

<p>My COPD Care</p> <p>This handout helps me understand how to take good care of my COPD.</p> <p><i>Put this paper where it can be easily seen and use it as a guide</i></p>	<p>My COPD medicines</p> <p>Inhalers for regular use:</p> <p>1 _____</p> <p>2 _____</p> <p>Rescue inhaler:</p> <p>1 _____</p>	<p>Getting Ready for my next clinic appointment</p> <p>My next appointment is on date: _____ time: _____</p> <p>Things I will discuss with my Doctor at next clinic visit:</p> <ol style="list-style-type: none"> 1. Do I have medicine refills? 2. Do I need to go to Pulmonary Rehab to be more active and breathe better? 3. Do I need oxygen at home? 4. Do I need any vaccine? 5. What is my rescue plan if my breathing gets bad again? 6. What help I can get to quit smoking (if I still smoke)
<p>Things I need before I leave the hospital</p> <p><i>Ask your nurse or doctor if anything is missing</i></p> <ol style="list-style-type: none"> 1 Get Inhaler education 2 Have inhalers supply in hand or ready for pickup 3 A clinic follow-up appointment within next 2 weeks 4 Be up-to-date on pneumonia & flu vaccine 5 Have set-up for home oxygen, if needed 6 Get help for quitting smoking, if I still smoke 	<p>Things to do If my breathing goes bad</p> <ol style="list-style-type: none"> 1 Use Rescue Inhaler as often as every 2 to 4 hours 2 Call Doctor's office. You can also call UCMC Discharge hotline (513-584-7474) 3 If you have Steroid medicine (Prednisone) then take it 40mg daily for 5 days. Let your doctor know that you started this medicine. 4 If breathing is difficult or does not get better, then call 911 or come to Emergency 	<p>Other things I want to remember</p> <p>_____</p> <p>_____</p> <p>_____</p>



eFigure 5: 'My COPD care' worksheet: This worksheet was developed as a tool for patient education and empowerment. It informs patients of what to expect during hospital stay, lists the inhaler names (to be written in blank space by patient at time of inhaler education), provided instructions about steps to be taken in case of worsening, educates patients on what to ask the physician at follow up appointment and provides space for additional notes. The written information has grade 6 readability.

Completion Rate (%) of COPD Care Bundle Elements



eFigure 5: Adherence (rate of completion) to individual bundle component measured weekly on % of components completed out of all available opportunities. Early increase in adherence was observed in ‘appropriate discharge medication prescription’ and ‘30-day supply of discharge inhalers’. Testing in these pharmacy processes was rapid due to fewer staff involved, early staff and leadership buy-in and early spread of new process. ‘Inhaler education’ was a new process, required building tools for education and optimization of education methodology during early testing. A training module for the respiratory therapy staff was developed and all 104 staff were trained, causing an expected delay in adherence to this process. ‘Standardized discharge instructions’ were first assigned to physicians, however, due to persistent unreliability, the process was redesigned and ‘My COPD Care’ work sheet (Figure S3) was created. This sheet was used for standardized instructions and was coupled with the ‘inhaler education’ process, resulting in higher reliability. ‘Follow-up clinic appointment within 15 days’ improved over time as the use of the newly tested process spread to all care-coordinators. This new process was a modification to a pre-existing process that was in place for other high risk and frequently admitted patients.

COPD: chronic obstructive pulmonary disease, d/c: discharge