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The I COUGH Multidisciplinary Perioperative Pulmonary Care Program: One Decade of Experience

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Background: Surgical quality improvement programs can provide meaningful benefits for patient outcomes, but sustainability of initial success is rarely described. In response to data that revealed a greater than predicted likelihood of postoperative pulmonary complications in one hospital, the study team designed a standardized program to improve care. This study offers a long-term perspective of the effort, including special challenges and lessons learned about sustaining success.

Methods: A before-after study was conducted at an academic safety-net hospital. A multidisciplinary team developed tactics to reduce pulmonary complications, designated by the acronym *I COUGH*: *I*ncentive spirometry, *C*oughing/deep breathing, *O*ral care, *U*nderstanding (education), *G*etting out of bed, and *H*ead of bed elevation. Clinical practices were audited and compared to actual and risk-adjusted pulmonary outcomes.

Results: Improvements in compliance with the I COUGH elements were initially promising, but baseline behaviors eventually returned. Adverse outcomes have inversely correlated with process adherence in "sawtooth" patterns. Rejuvenation efforts have successively extended beyond the literal principles of the acronym to foster broader institutional commitment to perioperative pulmonary care, restoring favorable trends in both process and outcomes. A more comprehensive I COUGH program now extends beyond the acronym, applying numerous concepts to support the original program.

Conclusion: I COUGH, a standardized perioperative pulmonary care program, initially improved performance and reduced pulmonary complications. However, loss of early program momentum corresponded with a return to baseline outcomes. Fortunately, an overall favorable trend has resulted from a coordinated rededication to I COUGH that requires steadfast commitment and creative responses to numerous cultural barriers.

Surgical quality improvement initiatives have gained widespread attention as the national and international health care climate evolves to promote patient safety, outcome-driven practices, value, and efficiency. Large registry programs that track patient outcomes, such as the American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP), the US Department of Veterans Affairs National Surgical Quality Improvement Program (VA NSQIP), and regional "collaboratives" have enabled health care organizations to study performance and to implement care strategies that address deficiencies.[1–3] The literature is replete with reports of local quality improvement programs that achieve initial success,[4–9] yet there are far fewer publications about permanently integrating successful practices into the fabric of an institution's culture. In fact, several authors have acknowledged great difficulty in sustaining successful quality improvement initiatives.[10–12] The tendency for organizational behaviors to revert to baseline after implementation of novel programs is a recognized phenomenon.[13] Programs that eventually fail can be a drain on financial, technical, and human resources. Strategies for sustaining favorable momentum in quality improvement are sorely needed.

In 2009, ACS NSQIP data revealed that our medical center was a high outlier for all measured postoperative pulmonary complications, including pneumonia and unplanned intubation. Recognizing an opportunity for improvement, we designed and implemented a standardized suite of interventions to reduce the incidence of adverse pulmonary events, and we demonstrated its immediate efficacy.[8] This program is designated by the acronym *I COUGH*, in reference to *I*ncentive spirometry, *C*oughing/deep breathing, *O*ral care, *U*nderstanding (education), *G*etting out of bed, and *H*ead of bed elevation.

After one decade of experience with the program, our goal was to analyze the natural fluctuations in the processes and outcomes of one quality improvement effort. We also aimed to describe the challenges to and strategies for sustaining long-term success.

METHODS

Development of the I COUGH Program

The implementation of the I COUGH protocol is detailed in a previous publication.[8] Institutional ACS NSQIP data for general surgery and vascular surgery patients showed

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Table 1. Orders Included in the Standardized Order Set

1. Educate patient about I COUGH protocol.
2. Incentive spirometry: Educate patient in use.
3. Incentive spirometry: 10 times every hour (3–5 efforts each set), while awake until discharge
4. Keep incentive spirometer within reach.
5. Document incentive spirometer volume every 4 hours while awake.
6. Head of bed elevated (> 30 degrees)
7. Out of bed to chair at least once on the day of the operation unless patient arrives from the postanesthesia care unit (PACU) late in the evening
8. Walk at least once on the day of the operation if patient arrives from the PACU by 4:00 P.M. if alert and safe to do so.
9. Out of bed to chair at least three times per day, preferably at mealtimes, with assistance as needed
10. Progress activity to ambulate at least three times per day, with assistance as needed.
11. Mouth care 8:00 A.M. and 8:00 P.M. including brushing teeth and rinsing with mouthwash
12. Encourage patient to cough and deep breathe every 2 hours.

Source: Cassidy MR, et al. I COUGH: Reducing postoperative pulmonary complications with a multidisciplinary patient care program. JAMA Surgery. 2013;148:740–745.

that our hospital was a high outlier for adverse postoperative pulmonary events (pneumonia and unplanned intubation) in 2009. In an effort to improve pulmonary care, we convened a multidisciplinary group that included representatives from the Departments of Surgery, Nursing, Anesthesia, Quality Improvement, Respiratory Therapy, Infection Control, and Physical Therapy, the ACS NSQIP team, and the Preoperative Assessment Clinic staff. The participants reviewed the surprisingly sparse literature about the prevention of non-ventilator-associated postoperative pulmonary complications[14] and developed a multidisciplinary strategy to reduce these adverse outcomes. The consensus was to promote lung expansion exercises, early and frequent patient mobilization, oral hygiene, and education as key components of a strategy to reduce postoperative complications. These elements are included in the acronym *I COUGH*. Order sets were developed and integrated into the electronic medical record to support physicians and establish standardized instructions for nursing practice (Table 1). We initially focused our efforts on general and vascular surgery patients because their data were captured in the ACS NSQIP data module and allowed us to identify the problem and monitor outcomes over time.

Education and Implementation of the I COUGH Program

A major initiative of the I COUGH program includes formal education of patients, their families, nurses, and surgeons and their teams. We composed brochures (Figure 1), a video, and posters with instructions that describe the techniques and value of postoperative pulmonary care and set expectations for postoperative recovery. These principles are introduced in the Preoperative Assessment Clinic and reinforced in the preoperative holding area. Patients are again instructed about I COUGH after their operations by nursing staff and by surgeons and house staff during rounds. Nurse educators and physicians also meet with unit nurses to review baseline pulmonary outcome data and to describe the necessity and importance of I COUGH principles. Expectations for care are clearly articulated, and attending surgeons and house staff are also engaged. The program was fully implemented on August 2, 2010. We introduced the program outside the surgery intensive care unit (SICU) to initially focus on ward-based pulmonary complications. However, when the relative incidence of complications increased in the SICU, we expanded efforts to that setting as well.

Audits of Practice and Data Feedback

Prior to the actual adoption of I COUGH, we audited practices in spring 2010. We observed patients who had undergone elective open abdominal or pelvic operations, with visits about 8:00 A.M., 1:00 P.M., and 6:00 P.M. on the day of surgery and during the two subsequent days. Nurses were unaware of these audits. Trained clinical staff noted whether patients were in bed, seated in a chair, or walking, and whether incentive spirometers were within reach. A total of 250 observations were recorded. We defined optimal practice as patients being out of bed (either sitting in a chair or walking), while having an incentive spirometer within reach when at rest. Although allowing patients to remain in bed was considered less desirable, we defined favorable practice as the head of the bed being elevated greater than 30 degrees for those patients observed while in bed.

The initial implementation efforts occurred between August 2010 and February 2011. During this time, the nurse leader for quality improvement educated nursing staff on all shifts. The surgeon champion presented the ACS NSQIP data as well as observational audit data of practices to reinforce the critical importance of I COUGH on each unit. After full implementation, we conducted 250 additional daily audits, and we provided weekly feedback to unit nurse managers. However, in February 2011 changes in personnel terminated the direct audit and feed-

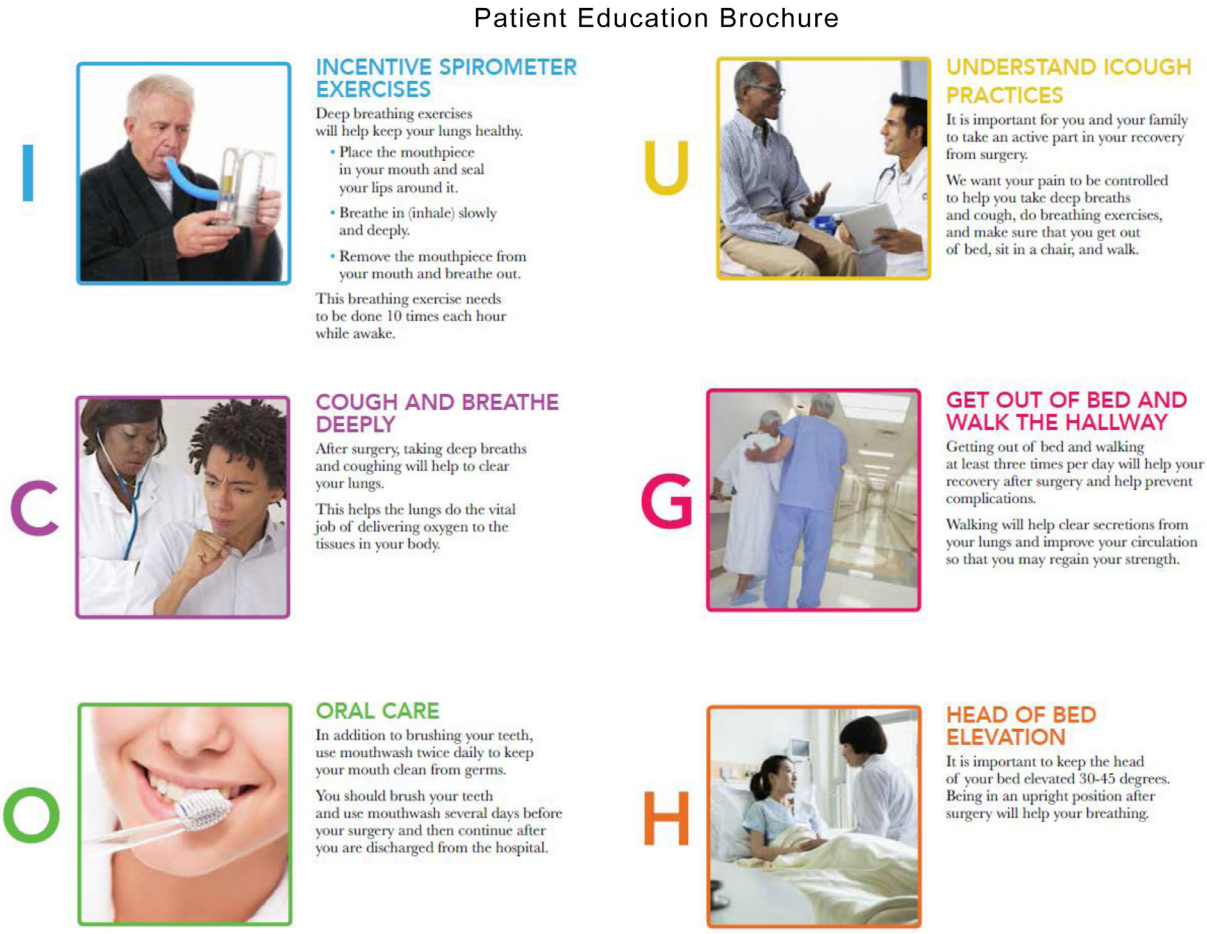

Figure 1: Shown is an example of a patient education brochure that features the elements of the *I COUGH* program.

back phase. Postimplementation audits then incorporated reviews of electronic records that had been designed to capture the care practices of interest. We correlated practice audits with outcome measures over time.

Lapse and Subsequent Rejuvenation of I COUGH Efforts

After initial success with the I COUGH program, support of its specified practices waned over time. There was a period of time during which resources lapsed for providing continued education, tracking care standards, and auditing postoperative practices. Although order sets were maintained in the electronic record and defaulted to select the I COUGH elements of care, we lost the ability to conduct direct observations of bedside care and to ensure adherence to process measures. In addition, I COUGH was not uniformly adopted by all surgical services, leading to confusion about standards for postoperative care among disciplines. These conditions required a redirection of institutional priorities. As a result, we resumed audits and multidisciplinary meetings to present feedback about performance and outcome data in fall 2012, including better and more regular engagement of frontline nurses and nursing leadership. Audits of practice were conducted daily for two months. We enhanced resources for patient education in the outpatient Preoperative Assessment Clinic with educational materials in multiple languages and media, along with visual aids to encourage patient ambulation (for example, photographs of Boston's Freedom Trail—patients are encouraged to set goals for walking to commemorations of historic landmarks). We also designed and implemented a robust pulmonary risk assessment and risk reduction program, identifying high-risk patients during Preoperative Assessment Clinic appointments based on known susceptibility factors. Respiratory therapy consultations were arranged for high-risk patients, including formal preoperative smoking cessation protocols when appropriate.

To create a uniform standard of care, we developed standardized pulmonary practices across all inpatient surgical services (extending I COUGH core practices to thoracic surgery, urology, orthopedic surgery, otolaryngology, and gynecology). In addition, we educated surgeons and encouraged coordination with anesthesiologists regarding perioperative fluid management, multimodal analgesia (with an emphasis on avoiding or minimizing narcotics), and techniques of mechanical ventilation (for example, smaller tidal volumes). We enhanced SICU education and care, including a program for mobilization of ventilated patients,

intervals of "sedation vacation," formal weaning protocols, and I COUGH patient instruction following liberation from mechanical ventilation. Finally, the hospital administration provided support for dedicated quality improvement personnel within the Department of Surgery. We have even recently developed a software application for handheld devices that are intended to coach individual patients about compliance with I COUGH principles following operations. After these rejuvenation efforts were implemented, we again audited practices in early 2013, conducting another 250 observations.

Outcome Measures

We used ACS NSQIP data from our institution to determine the impact of I COUGH on postoperative pulmonary outcomes. Patients who underwent an operation on the general surgery and vascular surgery services at our institution and who were included in the ACS NSQIP review process—which captures a representative selection of total cases—were included in the analysis of ACS NSQIP data. This analysis contains both SICU and non-SICU patients. The 30-day absolute incidences of postoperative pneumonia and of unplanned intubation, as defined by ACS NSQIP, during the one year before implementation of the I COUGH program were compared to multiple subsequent one-year periods. We correlated trends with adherence to the process parameters of the I COUGH program when institutional resources allowed for direct observational audits. ACS NSQIP defines patients with pneumonia as having at least one definitive chest radiologic exam, at least one sign of infection (for example, fever, leukocytosis, or altered mental status with no other cause), and at least one microbiologic laboratory finding (positive cultures from blood, bronchoalveolar lavage, or pleural fluid specimens). An alternative definition of *pneumonia* includes at least two signs or symptoms (from among purulent sputum, worsening cough, dyspnea or tachypnea, rales or rhonchi, or worsening gas exchange). Either definition was considered acceptable. *Unplanned intubation* is defined as placement of a breathing tube that was not intended or planned, excluding instances of intubation during a return to the operating room. We also compared risk-adjusted pulmonary outcomes, which ACS NSQIP reported as observed/expected ratios (O/E) before calendar year (CY) 2010 and as odds ratios (ORs) for CY 2010 and later. The O/E and OR values are considered to be statistically comparable for large sample sizes. Pearson correlation coefficients were calculated comparing the audited rates of incentive spirometry and patients being out of bed with the risk-adjusted ratios of pneumonia and unplanned intubation over time.

Institutional Review

This study was approved by the Institutional Review Board of the Boston University School of Medicine.

RESULTS

The pre–I COUGH nursing practice audit revealed that only 20% of patients were out of bed, either in a chair or walking, at the time of the surveyors' visits. We observed rapid improvement in care after the initial introduction of I COUGH, with 69% of patients being out of bed. However, two years later, compliance with the standard nearly returned to baseline at 29%. With rejuvenated quality efforts, 60% of patients were found to be out of bed. Availability of an incentive spirometer initially increased from 53% before I COUGH to 77% after I COUGH. With the loss of momentum, only 41% of patients had an incentive spirometer within reach, but this improved to 94% with redirection toward the program elements (Figure 2).

The pulmonary outcomes temporally, and inversely, correlated with these fluctuations in care standards. Immediately after the introduction of I COUGH, the incidence of adverse pulmonary outcomes decreased. The absolute incidence of pneumonia fell from 3.0% before I COUGH to 1.8% after I COUGH, before climbing again to 2.2%. Finally, this value improved to 0.4% with the rejuvenation efforts (Figure 3). The ACS NSQIP reported that risk-adjusted ORs during the same intervals were 2.13, 1.58, 2.25, and 0.9 respectively, reflecting the patterns in care (Figure 4a). Over the entire period, this represents an improvement from the 10th decile to the 1st decile of ACS NSQIP hospitals for pneumonia. The Pearson correlation coefficient comparing risk-adjusted pneumonia ratios with incentive spirometry and out of bed rates were -0.98 and -0.79, respectively.

The incidence of unplanned intubations at our institution was 2.3% before I COUGH and declined to 1.4% after its introduction, before rebounding to 1.8% and finally improving to 0% (Figure 2). Risk-adjusted ratios for the same time periods were 2.10, 1.31, 1.83, and 0.78, respectively (Figure 4b). The Pearson correlation coefficient comparing risk-adjusted unplanned intubation ratios with incentive spirometry and out of bed rates were -0.91 and -0.90, respectively.

DISCUSSION

Adherence to the process principles of I COUGH distinctly and inversely correlates with the incidence of pulmonary complications. Early clinical success was based on involvement of a multidisciplinary team in all stages of planning and development, significantly increasing staff interest and engagement (buy-in), and instilling a sense of commitment and pride in a locally developed quality improvement program. Standardization of postoperative pulmonary principles established expectations for the care of patients on the participating surgery services. The simplicity of the interventions described in the I COUGH program would seemingly imply that they are easy to understand, disseminate,

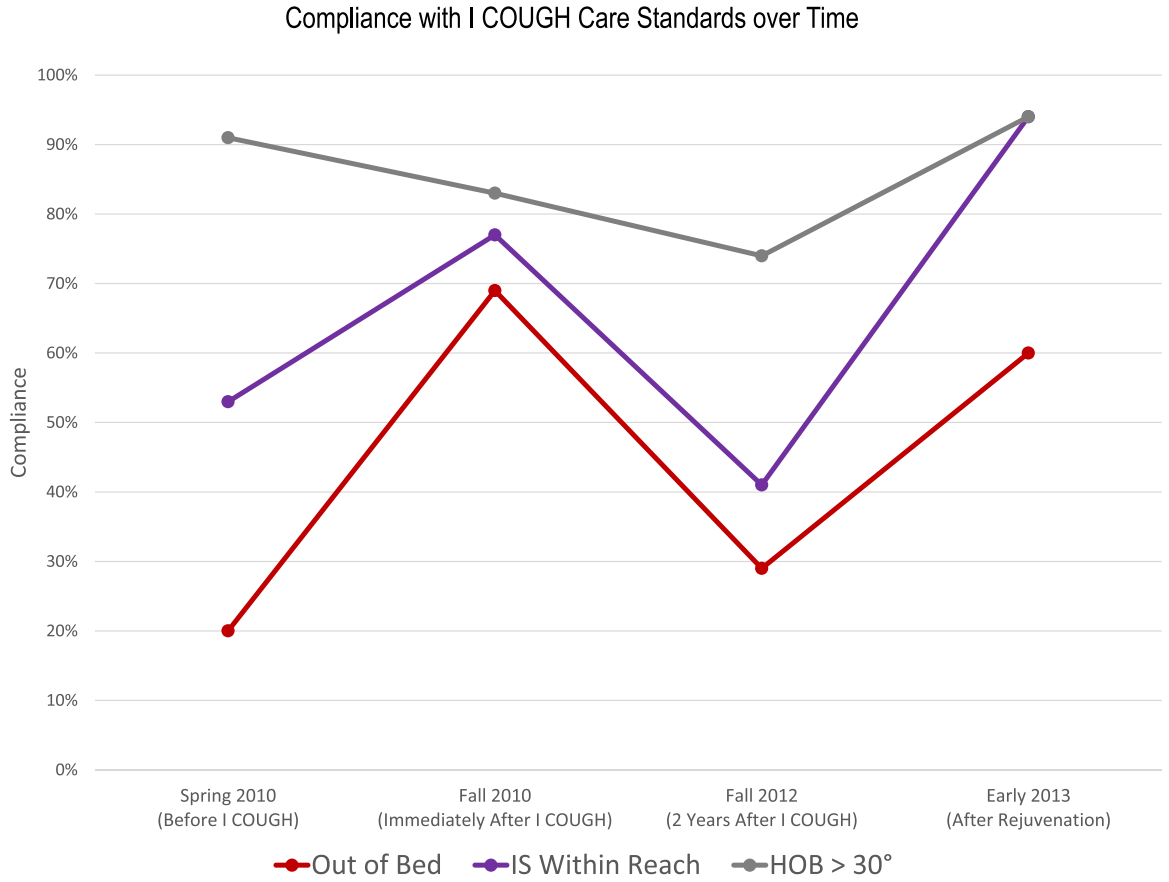

Figure 2: This graph illustrates the percentage of compliance with the following I COUGH care principles: being out of bed, having an incentive spirometer within reach, and having the head of the bed elevated more than 30° if the patient is observed in bed, based on the number of observations, over time during the various phases of I COUGH implementation. IS, incentive spirometer; HOB, head of bed.

and perform. In addition, the education of patients, families, staff, and surgeons was beneficial during the early stages of this program.

The erosion of the initial I COUGH momentum was certainly disappointing and likely due to a variety of factors. Foremost was the loss of institutional support of personnel to conduct practice audits and to provide education to staff and to patients. The initial implementation phase was therefore too short to ensure enculturation of practices. The loss of personnel also resulted in an inability to provide ongoing performance feedback. And when the feedback was instituted once more, it was occasionally misconstrued as confrontational rather than collegial or supportive. Another failure included the fact that this program was initially not extended to all surgery subspecialties. This disrupted the uniformity of postoperative pulmonary care among the services, often creating disparate expectations for patient care on the same geographic nursing unit. Importantly, there was also a loss of the sense of novelty and enthusiasm for the program as other efforts became priorities. An innocent moment of candor by one clinical leader—"I thought I COUGH is out this year and patient satisfaction is in"—perfectly captures the true lament of sustaining quality improvement efforts.

A return of clinical practices to baseline led to a deterioration of pulmonary outcomes. As a result, the original principles of I COUGH required revitalization, but in a much more comprehensive manner to buttress the desired precepts of care. With the wide-ranging actions outlined in the Methods section, pulmonary care practices have once again improved and adverse outcomes have declined. This revitalization required intense dedication of quality improvement personnel and a surgeon champion, with involvement from representatives of frontline staff. Overall, the trend in outcomes has been favorable. In the decade since the original inception of the I COUGH program, we saw improvement from the 10th decile to the 2nd and 1st deciles of ACS NSQIP hospitals for pneumonia and unplanned intubation. The program resulted in meaningful reductions in adverse pulmonary outcomes among our patients when the sustainability of the program was optimized.

The vexing vacillations of practices and outcomes in the I COUGH program are not unique. Instead, they exemplify

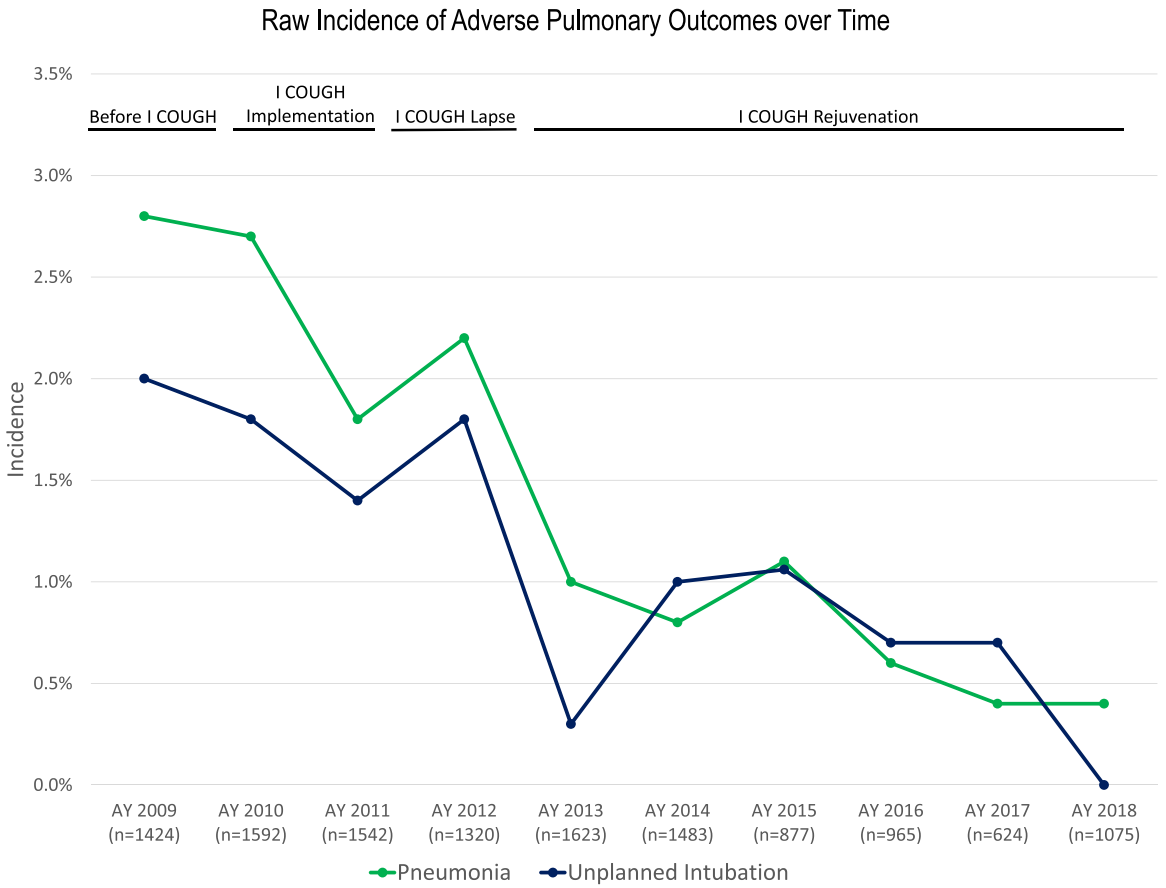

Figure 3: This graph shows the raw incidences of pneumonia and unplanned intubation over time during the various phases of I COUGH implementation, based on American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP) data. AY, academic year (July to June).

what sustainability science has demonstrated—specifically, that the natural history of these efforts commonly involves a loss of fidelity over time.[10,12,13] However, this phenomenon may be mitigated by adherence to principles of sustainability. A systematic review of health program sustainability suggests that the aspects of initial program design that portend success include multidisciplinary planning, involvement of key stakeholders, leadership support, presence of a program champion, and availability of workforce resources.[12] Gaining workforce commitment can be bolstered by promoting widespread participation, communicating a clear and consistent plan, and demonstrating high visibility of processes, goals, and rationale.[15,16] Postimplementation strategies are as important as the initial construct. In case studies of successful and unsuccessful quality initiatives, important characteristics of sustained success include continuous internal audits and frequent feedback of patient-centered outcomes, ongoing education, dedicated support staff, collaboration, communication, and uninterrupted funding.[17,18] Adhering to these sustainability principles in the implementation phase of the I COUGH program may have prevented the loss of momentum that was observed, and these principles have helped revitalize the program.

Cultural aspects of the institution may also profoundly influence sustainability. Successful programs must coincide with the organization's key mission.[13] The local environment in which a program is implemented, and the level of commitment to that program, may indeed be more important than the elements of the program itself. For example, the standardized enhanced recovery after surgery (ERAS) program was almost simultaneously implemented in 33 hospitals in the Netherlands between 2006 and 2008. Gillissen and colleagues studied hospital-specific variations, in terms of adherence to the protocol and associated outcomes over three to five years.[10] They discovered significant variation in performance measures, the primary outcome (length of stay), and sustainability among the hospitals. This general observation suggests that local implementation strategies and dedication may account for the variable successes of certain quality initiatives. The naturally evolving culture at our hospital contributed to both the successes and the lapses in our efforts to reduce postoperative pulmonary complications.

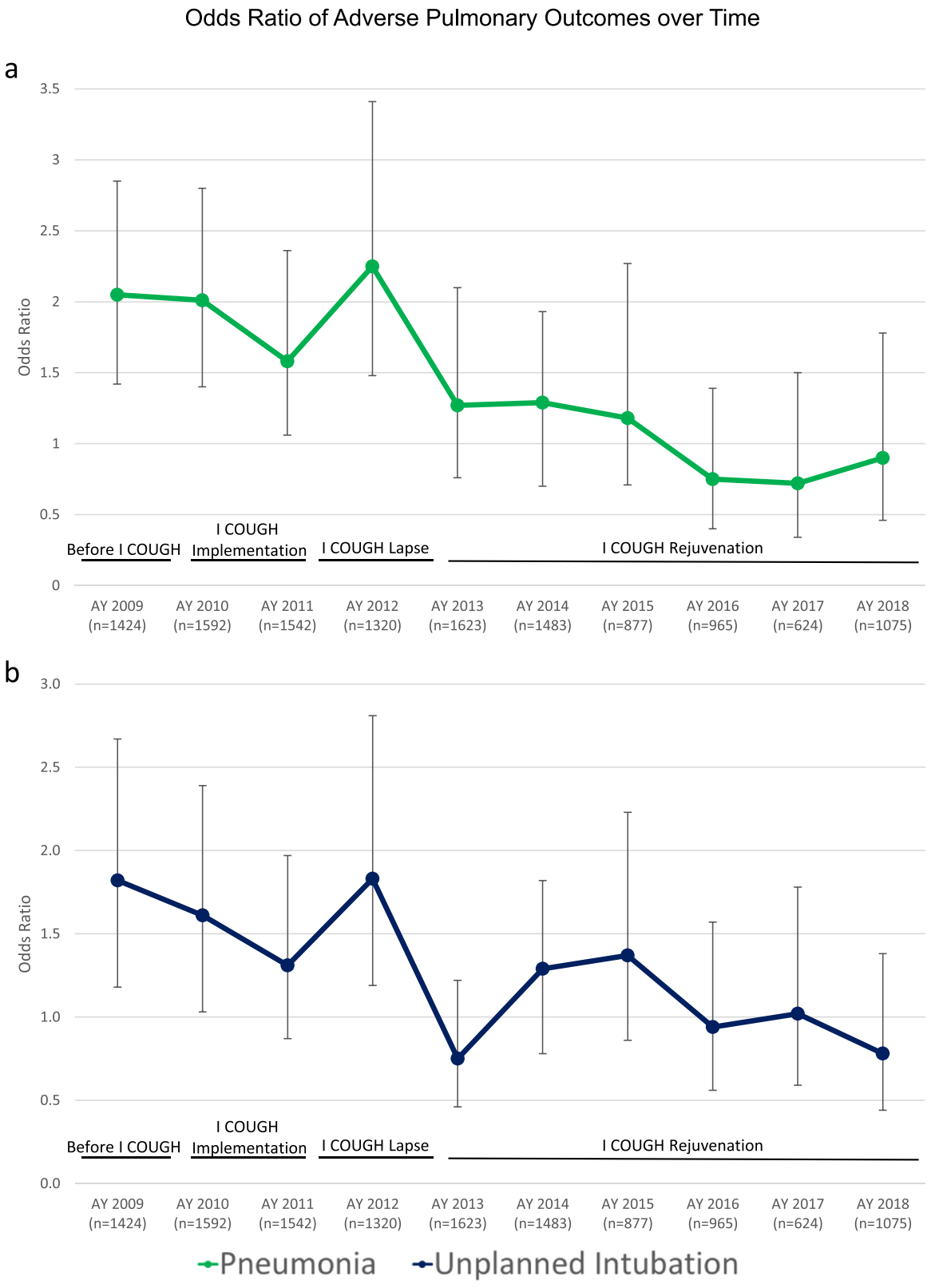

Figure 4: These graphs show the American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP) risk-adjusted data, which include odds to expected ratio (for time points before 2010) or odds ratio (for time points after 2010) during the various phases of I COUGH implementation. AY, academic year (July to June).

Several methodological features limit this study. We conducted the pre–I COUGH audits by observing actual nursing care practices. During some post–I COUGH periods, personnel performed audits through reviews of medical record fields that had been designed to capture process measures of interest. Even still, dramatic differences in nursing practice were recorded between the pre– and post–I COUGH audits, and we believe that true changes in practice did occur and were reliably detected.

We are confident that the elements of care outlined in I COUGH are truly effective. This contention is supported by the inverse association between compliance with the process measures and adverse pulmonary outcomes. However, during the course of regaining the lost momentum of I COUGH, we recognized that a comprehensive quality improvement program has to be more than a clever acronym. We also critically analyzed barriers to I COUGH implementation in our safety-net hospital and focused on several specific tactics to buttress the desired care components. Although it is known that organizational culture change can take years to achieve,[19,20] inspiration from the early successes of I COUGH prevented us from abandoning efforts to firmly ensconce its practices within our institutional clinical behavior. The momentary lapses in this initiative did not deter us. Although the seemingly basic components of care invoked by I COUGH have required more effort to instill and sustain as practice habits than we had originally anticipated, the favorable trend in outcomes during the past decade has definitely emboldened our resolve to persist in this program, to regard its failures as opportunities to learn and improve, and to adapt to continuously improve the postoperative care of patients.

CONCLUSION

The I COUGH protocol reduces postoperative pulmonary complications when institutional culture is optimized around adherence to its principles, but momentum can be easily lost in the absence of active program maintenance. The success and sustainability of the I COUGH program depends on a complex interaction of local population health concerns, dedication of stakeholders, financial support, human resources, and the organizational environment. Initiatives to limit complications must be flexible, multifaceted, and coordinated. Mature quality improvement programs do not rely on perfection de novo but instead progress with incremental and deliberate refinement. Ultimately, momentum can be sustained only by establishing a commitment to quality as the essence of the institution's culture.

Conflicts of Interest. All authors report no conflicts of interest.

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