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Lessons learned from the northern New England Cardiovascular Disease Study Group

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ABSTRACT

The Northern New England Cardiovascular Disease Study Group (NNECDSG) has since 1987 leveraged prospective data collection seated within the setting of a regional collaborative to drive quality improvement in cardiac surgery across 8 medical centers in Maine, Vermont and New Hampshire. While our efforts have been focused in the setting of adult heart surgery, similar methods have been extended outside of northern New England and in other clinical areas, including vascular surgery, cystic fibrosis, and perinatal care. In this article, we described the history and methodology by which the NNECDSG has attained its success, and end this article with suggestions for how such a collaborative effort might be extended to the field of pediatric and congenital heart surgery.

1. Introduction

Take yourself back to the late 1980s. Ronald Reagan was in office, and the Dow Jones had just surpassed 2000 points for the first time. Now, imagine you are a heart surgeon, and received an envelope from the Health Care Financing Administration (HCFA, now called the Centers for Medicare and Medicaid Services). You open the letter, and note your mortality rate for cardiac surgery, along with a "gentle" nudge suggesting that you need to reduce it to continue to receive financial remuneration from the largest US health care insurer. Such a letter was sent to every American heart surgeon. What is one to do? Options: (1) throw the letter away (recycling was not even a fad back then) and dismiss its findings; (2) put the letter at the bottom of your desk pile along with your journal subscriptions and paper medical records; or (3) consider a way of addressing their claims and proving them invalid.

Dr. Stephen Plume, section leader for cardiothoracic surgery at Dartmouth-Hitchcock Medical Center in northern New England,[1] took this letter on as a personal challenge. He approached Dr. Gerald O'Connor, a Harvard-trained cardiovascular epidemiologist, to work with him to determine whether HCFA was correct in their calculated suboptimal outcomes. There were no electronic medical records to determine the number of cases that a surgeon performed, let alone what percentage of the patients operated survived or died. There was no gold-standard methodology for measuring whether the mortality rates provided by HCFA were indeed correct. They also recognized that it was difficult for one surgeon to have had enough experience in conducting heart surgery to distinguish noise from any real signal in interpreting the mortality rates.

Drs. Plume and O'Connor approached other heart surgeons in northern New England in an effort to develop a collaborative approach for addressing HCFA's shot across their bow. They gathered representatives from all 5 regional programs in Maine, Vermont and New Hampshire.[2] The representatives agreed at the end of the meeting that this was an important issue to tackle; that, they were well suited as a group rather than as individuals to determine whether HCFA's calculations were right; and, they would need to think strategically to address HCFA's concerns. Most importantly, the group agreed to meet again.

Over several meetings the group (later to be called the Northern New England Cardiovascular Disease Study Group, NNECDSG) agreed to develop a standardized one-page data form to collect essential information about each patient and procedure conducted within their medical centers. The data form would enable the group to: (a) address concerns about HCFA's ability to appropriately adjust mortality based on case-mix, and, (b) ensure that all (relevant) cases were submitted. Development of the data form took significant time especially given that no other cardiac registry existed at the time. The group felt

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[1] Northern New England encompasses the states of Vermont, New Hampshire and Maine.

[2] It is important to note that such an approach was unique. While natural mountain ranges separated Dartmouth-Hitchcock Medical Center from the other four regional medical centers providing cardiothoracic surgical care, those invited represented Dartmouth's and Dr. Plume's traditional competitors.

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it was important to limit the number of data variables collected, and agreed on each of collected variables's definition.

The NNECDSG published their first findings four years after HCFA's public reporting of mortality rates [1]. We found that across the regional medical centers there were significant observed differences in mortality rates. The differences were surprisingly independent of case mix, and suggested that apparent differences in mortality were attributed to variation in the processes of delivering care. The findings were humbling, yet, they help focus the mission and activities going forward.

1.1. Milestone papers

The group agreed it was necessary to know a patient's pre-operative risk of mortality. At this time, there were no "off the shelf" risk prediction models, so the group developed one of the earliest models in this area [2]. These models allowed clinicians to communicate a patient's estimated pre-operative risk of mortality in a standardized format to help inform treatment decisions. Instead of a surgeon saying, "Your risk is about 3%", surgeons could now say, "For patients *like* you, 3% will die during their index admission to the hospital". The word *like* reflects the fact that the estimation of risk utilizes information customized to the patient's own disease state. The models utilized prior regional experience to guide the decision for surgery. We initially programmed Hewlett Packard calculators, and later moved towards pocket cards and web-based tools to disseminate the prediction models.

Next, the group used our data to identify the opportunities for reducing mortality across northern New England. Our group developed a three stage plan for reducing mortality that included: (1) provide timely and accurate data back to the clinical teams regarding their surgical performance and outcomes; (2) train the multi-disciplinary teams in quality improvement principles; and, (3) conduct site visits to each other's medical center to learn how each group actually delivers care [3]. These activities resulted in 74 fewer deaths than would have been otherwise expected, and a 24% reduction in mortality over a period of 2 years. Our findings were consistent across patient subgroups. Much of this improvement occurred by leveraging and addressing ways to reduce the variation in the delivery of care, rather than by fixing blame on individual clinicians.

The group believed we could further improve the care we delivered by understanding why their patients died after coronary artery bypass graft (CABG) surgery. We were interested in knowing the seminal events that may have led to a series of cascading events that ultimately resulted in the patient's death. For instance, a patient may have had a stroke, and was subsequently put on a ventilator, developed aspiration pneumonia and died. While the cause of death may have been aspiration pneumonia, the "mode of death" that greatly contributed to the patient's death was the stroke. We felt that if we understood the mode of death across different surgeons in our region, we could identify the processes of care that could be modified to reduce the principal modes of death. Our work involved 23 surgeons and the investigation of 387 deaths among 8641 isolated CABG procedures performed between July 1987 and May 1991 [4]. The principal mode of death–heart failure, accounted for 65% of deaths. It also accounted for 80% of the differences across terciles of surgical risk.

This information led to a subsequent regional improvement effort, leveraging not just surgeons, but other surgical team members, including anesthesiologists, nurses and perfusionists. We first developed a risk prediction model for fatal low cardiac output (LOF). Second, we created a decision matrix that outlined how we would care (e.g., pre-, intra- and post-operatively) for patients based on their risk of fatal LOF (Fig. 1). This matrix was the product of systematic literature searches, our own regional data and professional opinions. Third, we developed, trained, and supported local quality improvement teams to implement processes of care found to be beneficial in reducing LOF. Fourth, we used our regional data registries to track the adherence to our agreed upon strategies. As a result, we lowered the rate of fatal LOF by 85% (1.37% to 0.74%, $p<0.001$) between 1996 and 2002.

Our fixation with mortality and other morbid events has not subsided. Further reductions in mortality have continued. By the end of 2010, we predict that at least 1279 fewer deaths had occurred due to our quality improvement efforts, than would otherwise have been expected. We have developed a number of other quality improvement efforts, including related to reducing neurologic injury [5], kidney injury [6], and transfusion rates and adverse outcomes [7], to name a few. These initiatives have used similar strategies, namely: clinical champions, a sound foundation of primary data collection, development and support of multi-disciplinary clinical teams, and well-defined aims.

1.2. Other regional collaboratives exist

We have been pleased to see the emergence of other regional learning collaboratives in [3] and outside[4] of cardiovascular surgery [3] including in domains of vascular care [4], perinatal care [5], cystic fibrosis [6] and trauma and rehabilitation [7]. These collaboratives, while focused in a number of areas, use similar methods for clinician engagement and a relentless focus on continuous quality improvement. Second, the Vascular Study Group of New England (VSGNE) has emerged to be a leader in driving quality outcomes in vascular surgery. The VSGNE is a regional collaborative comprised of vascular surgeons in all New England states. The VSGNE validates its registry data with administrative data, develops and disseminates reports for quality assurance and improvement. Similar to the NNECDSG, the VSGNE also uses semi-annual meetings to build trust, discuss potential interventions and focus the group's work.

2. Conclusions

Would this work for pediatric cardiovascular care?

Pediatric cardiac care has improved the outcomes of children with cardiac injuries but a large, 3 to 4 fold variation in outcomes continues [8]. The methods used by our group are broadly generalizable to all areas of clinical medicine, and likely would work well in the setting of pediatric cardiac care. From our experience, some of the following elements are necessary prerequisites:

- Physician leadership: Physicians need to buy-in to the idea and value of a learning collaborative, but also engaged and willing to be an integral part and presence.
- Validated datasets: It is imperative that the group agrees in principle and ensures the integrity of the data that is used to drive quality assurance and improvement activities. As my mentor Dr. Gerry O'Connor says, "You don't want people arguing about your methods and your results at the same time". Your best friends and allies are your database managers. Never loose site of their dedication and value.
- Develop and stick to your mission: Develop a mission that you and your colleagues are willing to stick to. Don't deviate from it.
- Use data to drive action: Your sole mission should be to use the data you collect to drive action on the ground. Ideally, stick to

[3] Michigan Society of Thoracic & Cardiovascular Surgeons (http://www.mstcvs.org/), the Virginia Cardiac Surgery Quality Initiative (http://www.vcsqi.org/), the Clinical Outcomes Assessment Program (http://www.coap.org/).

[4] Vascular Study Group of New England (VSGNE, http://www.vsgne.org), [5] Northern New England Perinatal Quality Improvement Network (http://www.nnepqin.org/), Northern New [6]England Cystic Fibrosis Consortium (www.nnecfc.org/), Vermont Oxford Network (http://www.vtoxford.org/) [7] New South Wales Trauma and Rehabilitation Collaborative, http://www.traumacollaborative.com/.

Pre-operative Calculation of Risk of Fatal Low Cardiac Output in CABG Patients

For use in patients having isolated CABG surgery; not valve or aortic surgery.

Variable	Fatal LOF Score	Example
Age 70-79	1.5	80 yr. old Female, 1st time CABG, Elective, EF<40, Diabetes Total score= 3+1.5+2.5+1.5 = 8.5, High Risk for Fatal Low Cardiac Output
Age ≥ 80	3.0	
Female sex	1.5	
Prior CABG	1.5	
Emergency	6.0	
Urgent	2.0	
EF<40	2.5	
3 Vessel Disease	1.5	
Diabetes	1.5	
PVD	2.5	
Renal Failure	3.0	

Risk Score and Predicted Probability

Fatal LOF Score	Percentiles	Risk Category
0-3	Bottom 45.5% of risk	Low Risk
4-6	Middle 44.5% of risk	Medium Risk
≥7	Top 10% of risk	High Risk

Definitions:

Emergent: Medical factors relating to the patient's cardiac disease dictate that surgery should be performed within hours to avoid unnecessary morbidity or death.

Urgent: Medical factors require patient to stay in hospital to have operation before discharge. The risk of immediate morbidity and death is believed to be low.

EF <40% (Left ventricular ejection fraction): The patient's current EF is less than 40%.

Diabetes: Currently treated with oral medications or insulin.

PVD (Peripheral vascular disease): Cerebrovascular disease, including prior CVA, prior TIA, prior carotid surgery, carotid stenosis by history or radiographic studies, or carotid bruit. Lower extremity (LE) disease, including claudication, amputation, prior lower extremity bypass, absent pedal pulses or lower extremity ulcers

Renal failure prior to surgery: On peritoneal or hemo-dialysis.

Pt. Risk Group	Pre-operative Care	Intra-operative Care	Post-operative Care
All risk groups (general care)	• Calculate risk of anemia on bypass. • Continue ASA • Adequate *b* -blockade. • Improved hand-off - cardiology and surgeon. • Avoid hyperglycemia	• Avoid anemia • Use IMA • Improved separation from bypass. • Avoid hyperglycemia	• Improved hand-offs between anesthesia and ICU nurse • Early recognition and prompt treatment(Tx) of low output heart failure. • Avoid hyperglycemia
Low risk (Risk score 0-3)	• No PA catheter.	• General care, • No inotrope use at separation	• General care
Medium risk (Risk score 4-6)	• General care. • PA catheter • Tx for unstable angina and/or CHF	• General care. • No inotrope use at separation	• General care. • Patient identified as medium risk to ICU
High Risk (Risk score ≥7)	• General and medium risk care. • PA catheter • Consider pre-op IABP.	• General and medium risk care • Retrograde cardioplegia • GIK and/or IABP	• General care. • Patient identified as high risk to the ICU staff

Fig. 1. The top two sections of this figure show a pre-operative risk prediction tool for estimating a patient's risk of fatal low cardiac output syndrome. The bottom section of the figure shows a matrix that our group has developed to assist clinical teams in identifying how to care (pre-, intra- and post-operatively) for patients to reduce fatal low cardiac output syndrome.

less than one 8 ½″ × 11″ page. Collecting data in the absence of action will be a fool's errand. Don't collect more than you can manage.
- Fellowship: This work is reliant upon building trust and friendship with other clinicians and colleagues. Break bread together. Don't underestimate the value of fellowship. Identify a time to meet, and try to meet 2 to 4 times a year. The meetings will keep the group accountable, and keep the group engaged in your work.
- Have fun: If you don't find this work rewarding, then stop.

It has been 25 years since HCFA shook up adult cardiac surgery by holding surgeons accountable to their outcomes. Nonetheless, there are outside forces at play these days. We are being asked to be accountable to our patients and society. If we can't show the value of care we provide, then the funding streams will stop. I am confident that pediatric cardiac care—cardiology and surgery would greatly benefit from developing a learning collaborative. We certainly have in adult cardiac surgery.

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