Three Learning Organizations in Cataract Surgery: The Example of Intracameral Antibiotic Injection

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E-pub: 05/19/2021 https://doi.org/10.7812/TPP/20.274

ABSTRACT

Background: The recent systematic adoption of intracameral antibiotic injection during cataract surgery in Sweden, India, and the US serves as a model for the successful transitioning of local quality improvement initiatives to organization-wide implementation. Although the delivery of eye care in the 3 countries is distinctly organized with differing governance and technological infrastructure, each contains elements of a learning organization (ie, an organization that has adopted a culture of creating, acquiring, and transferring knowledge into practice through system-level and clinician-level change).

Methods: We describe a retrospective and organizational implementation study of intracameral antibiotic injection in Sweden, through the efforts of the National Cataract Registry; in the US by Kaiser Permanente; and in India by the Aravind Eye Hospital System. Leadership structure, training in problem solving, benchmarking, sharing of technical knowledge, and data and workforce engagement are compared.

Results: Each of the 3 organizations share the key elements of effective leadership, which values the exchange of ideas in the workforce, training and resourcing for change, and information management in the form of benchmarking and data sharing. In the case of intracameral antibiotic injection, a new technique was identified to improve quality and safety with a reduction in infections as evidence of the success of the programs.

Conclusion: Committing to a culture of collective learning, and leveraging each stakeholder’s personal investment, health-care systems may improve care delivery and set new benchmarks in quality and safety.

INTRODUCTION

The increasing tempo of medical advances and accumulation of knowledge-dense, heterogenous information can lead to the difficulty for individual clinicians to keep current.1 A potential solution involves a system-wide commitment to the cultivation and exchange of new ideas, and dissemination of successful practices across component clinical departments.

Peter Senge and others developed the concept of a learning organization in the 1990s as a way for companies to respond rapidly to changes in the consumer and corporate environment.2,3 In the nonprofit sector, the model has been shown to correlate with greater knowledge and better financial and mission performance.4 Frontline workers and managers in learning organizations have demonstrated stronger organizational commitment, greater job satisfaction, and greater productivity.5,6 In the health-care setting, the benefits of learning accrue not only to employees, but also to patients and society, by providing safe and effective care at a better value. Perhaps for this reason, some have proposed scaling the learning organization to the national level.7

Learning and its contribution to innovation and change are influenced by an organization’s strategy, structure, communication practices, and social context.8 Senge emphasized engagement of organizational stakeholders at every level and the organic development of improvement ideas that, if successful and resourced properly, could be scaled and implemented.1,3 Schilling and colleagues9 identified 6 “building blocks” for achieving a learning organization: leadership structures, beliefs, and behaviors; real-time sharing of meaningful performance data; internal and external benchmarking; workforce engagement and informal knowledge sharing; formal training in problem-solving methodology; and technical knowledge and sharing. We use Schilling’s building blocks (Table 1) to illustrate the key system-wide implementation practices among ophthalmic surgeons in 3 different organizations: the study, adoption, and implementation of intraocular antibiotic injection at the conclusion of cataract surgery for the prevention of endophthalmitis, a potentially blinding infection involving all layers of the eye.

Sweden

Swedish health care is administered by local county authorities, and is financed through taxation and fixed patient fees. Prompted by an increase in demand and longer wait times for cataract surgery, the Swedish National Board of Welfare commissioned the Swedish Ophthalmological Society to convene a blue-ribbon panel to provide solutions to access and efficiency. The expert group created the Swedish National Cataract Register (NCR), a nonprofit...
### Table 1. Learning organization building blocks and organizational examples

<table>
<thead>
<tr>
<th>Building block</th>
<th>Sweden</th>
<th>Kaiser Permanente</th>
<th>Aravind</th>
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<tbody>
<tr>
<td><strong>Leadership structures, beliefs, and behaviors</strong></td>
<td>• The NCR is a joint effort of The Swedish Ophthalmological Society and The Swedish Association of Local Authorities and Regions</td>
<td>• Department and regional chairs who meet periodically to align priorities with executive leadership</td>
<td>• Single institution with standardized protocols and network of tertiary, secondary, and primary eye care centers</td>
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<td>• Regionwide peer groups in ophthalmology, risk management, and infection control and prevention</td>
<td>• Department and hospital heads who review data regularly and benchmark among the centers</td>
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<td><strong>Formal training in problem-solving technology</strong></td>
<td>• The NCR provides a formal framework for adding data elements to solve important questions</td>
<td>• Department chiefs trained in A3 and Lean management</td>
<td>• Physician quality managers, trained in analysis, who liaison between surgeons and department heads</td>
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<td></td>
<td>• Leadership integrated with risk management and infection prevention at each medical center</td>
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<td><strong>Internal and external benchmarking</strong></td>
<td>• Annual reports benchmarking local and national rates of endophthalmitis</td>
<td>• Quarterly reports benchmarking endophthalmitis</td>
<td>• Semiannual infection control meetings benchmarking endophthalmitis rates overall and in high-risk eyes, culture positivity rates, type of presentation and visual outcome among other measures</td>
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<td>• Large array of data elements, including patient and surgical characteristics</td>
<td>• Online reporting to department chiefs of local endophthalmitis rate compared to regional rate; regional rollout report to regional chiefs</td>
<td>• Unified medical record</td>
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<td>• Government health authorities who may compare and rate larger contracted units</td>
<td>• Leadership integrated with risk management and infection prevention at each medical center</td>
<td>• Web-based benchmarking for all the metrics</td>
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<td><strong>Technical knowledge sharing</strong></td>
<td>• Pharmacists and staff who follow standard protocols for compounding</td>
<td>• Regional meeting of department chairs</td>
<td>• Linked to ICHOM to benchmark with other institutions</td>
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<td>• Presentations at national society meetings</td>
<td>• Regional meeting of department chairs</td>
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<td>• Integrated pharmaceutical manufacturing arm</td>
<td>• Weekly web-based clinical meetings</td>
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<td><strong>Real-time sharing of meaningful performance data</strong></td>
<td>• Web portal with a full data set</td>
<td>• Infection prevention and OR leadership monitoring infections in real-time</td>
<td>• Web-based portal</td>
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<td>• Monitoring and analysis of endophthalmitis rates monthly and regionally</td>
<td>• Department heads and surgeons with access to real-time data</td>
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<td><strong>Workforce engagement and informal knowledge sharing</strong></td>
<td>• Staff meetings with quality and OR personnel</td>
<td>• Single physician group</td>
<td>• Adverse events reporting through an intranet platform</td>
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<td>• Communication links between registry and a local, clinical unit representative</td>
<td>• Web-based educational conferences</td>
<td>• Web-based educational conferences</td>
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<td>• Link to national accreditation</td>
<td>• Mentors work with surgeons who need support to refine their surgical techniques</td>
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<td>• Self-reporting of near misses</td>
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ICHOM = International Consortium of Health Outcome Measurement; NCR = National Cataract registry; OR = operating room.
entity, in 1992. The initiative coincided with the Swedish government’s decision to offer added financial means to reduce the backlog in practically all fields of health care in the country. Ophthalmologists were eager to participate, with the prospect of receiving additional resources to improve access to cataract surgery.

The NCR board is comprised mainly of experienced cataract surgeons who are active in clinical research, and its manager is appointed in agreement with the board of the Swedish Ophthalmological Society. This leadership structure contributes to a sense of legitimacy among constituent ophthalmologists. The NCR board also coordinates and finalizes proposed registry items and research activities, which come from constituent ophthalmologists or the board itself. Participation is either mandatory or strongly recommended by the regional administration. Currently, the NCR covers 97% of all cataract procedures in the country.

The NCR provides the formal structure for the creation of registry elements designed to answer important questions related to cataract surgery. With the annual volume of cataract surgery in Sweden increasing from 39,000 in 1992 to 54,000 in 1998, and an endophthalmitis infection rate during that time of 0.26%,10 ophthalmologists in the country recognized the need to track postoperative infections accurately on a nationwide scale with an eye toward lowering the infection rate. As a consequence, the NCR board added postoperative endophthalmitis as a measure to the registry in 1998 in addition to other data elements already in place, such as patient age, visual acuity, ocular comorbidity, type of cataract surgery, and intraocular lens type. This offered an exceptionally large and nonselected control group for detailed studies of risk factors for postoperative infection. During this time, a Stockholm university clinic introduced prophylactic intracameral cefuroxime (injection into the anterior chamber, the space between the cornea and the iris) with the idea that high antibiotic concentrations inside the eye would outperform the traditional topical or subconjunctival (injection under the surface lining of the eye, but not inside the eye) routes of antibiotic administration in terms of prevention.

The trended endophthalmitis data have been presented at the NCR annual users’ meeting since 1999 and at numerous Swedish Ophthalmological Society meetings and large congresses in Europe. The results have also been published in peer-reviewed journals.10-12 The much higher incidence of endophthalmitis in the group of patients who received only topical or subconjunctival antibiotics perioperatively in both Stockholm, and the NCR data, led to a nearly 100% adoption of intracameral cefuroxime in the early 2000s throughout Sweden.10,11 This validated the expected benefit of injecting antibiotic directly into the anterior chamber of the eye at the conclusion of surgery.

The NCR distributes data sets quarterly to medical directors, corresponding surgeons, and personnel of all reporting clinics, benchmarking individual surgeons and local units with national outcomes. Accredited users also have real-time access to all data via the NCR’s web portal. This has been a strong motivator for participation by units and for bearing the costs of registration. Aggregated data are available at the registry homepage (http://rcsyd.se/kataraktreg/publikationer/arsrapporter) in the form of an annual report displaying trends over time. These results, as well as current real-time data, are discussed at staff meetings of the participating units along with quality and operating room personnel if needed. Each ophthalmic center has an appointed representative, most often a clinician, with whom the data management officer of the NCR corresponds. This is required if, for example, a unit experiences more endophthalmitis cases than expected in a short time frame. The registry can, in a matter of hours, provide the unit with additional data looking back over a longer period of time, increasing the sensitivity and specificity of identifying clinically significant trends in infection rates.

Kaiser Permanente

In the US, most cataract surgery is covered by Medicare. Kaiser Permanente nationwide covers more than 8 million insured members in 7 states and performs approximately 3% of the 3.5 million US cataract surgeries annually. Kaiser Permanente Northern California (KPNC) is 1 of 8 geographical regions in the US and includes 21 medical centers, each with an ophthalmology department and surgery center.

In 2007, medical center risk management, patient safety, and infection prevention departments across the country, reporting to their regional and national centers, identified an increasing trend of endophthalmitis in postoperative cataract surgery patients reaching 0.23%. This was higher than national benchmarks, although there was a trend at that time toward increasing rates of endophthalmitis.13 The group convened a national committee of ophthalmologists and operating room, environmental services, risk, and infection control experts in the organization.

The committee developed revised cleaning and sterilization guidelines. In KPNC, the guidelines were distributed electronically to operating room leadership, and infection control and risk management who, in turn, trained local medical center staff and implemented the best practices. The following year, the infection rate fell to 0.084%, which was back to the prior baseline.

Concurrently, ophthalmologists in 1 KPNC department noted the recent publication of a study showing the benefit of intracameral cefuroxime injection in reducing
endophthalmitis. With the assistance of the hospital compounding pharmacy personnel, the injections were implemented in the department within 3 months. The initial endophthalmitis rate decreased by 2-fold in the first 2 years and, with the subsequent addition of moxifloxacin for allergic patients, the rate decreased another 10-fold over the ensuing 3 years. The results were presented to the regional ophthalmology chief's group and infection prevention physician and nursing groups.

Adoption of the injection was implemented throughout the KPNC regional network within the year, aided by the support and integration of pharmacy personnel in the region. By 2013, virtually all surgeons were injecting intra-cameral antibiotic, and the regional endophthalmitis rate had fallen to 1 infection in 7000 surgeries, comparable to the very low rates observed in Sweden. By 2014, implementation reached all regions in Kaiser Permanente nationwide through a web of interregional specialty department meetings as well as through infection prevention and quality assurance collaborations. The bidirectional flow of information and innovation between centralized leaders and frontline clinicians produced a rapid change in surgical practice, and in the sourcing, compounding, and delivery of a pharmaceutical within a year’s time.

Aravind Eye Care System

Surgeons perform 7 million cataract surgeries in India each year. Of these, 315,000 (5%) are performed at the Aravind Eye Care System (AECS) in southern India. AECS is a network of eye hospitals that includes 7 tertiary eye centers, 7 secondary eye hospitals, 6 secondary outpatient clinics, and 90 primary eye-care centers. AECS provides care based on a cross-subsidizing service model. Private, paying patients provide income for 60% of the charitable provision of care in hospitals and for community outreach using mobile surgical camps.

A chief medical officer (CMO) heads each of the hospitals, reporting to the physician chairman, who also heads the quality division. The CMO and heads of departments (HODs), along with local administrators, are responsible for the overall functioning, systems, and quality initiatives in the respective hospitals and departments. The CMOs and HODs from all hospitals meet via videoconference once a week to discuss quality and service initiatives and challenges, along with other aspects of clinical care.

The CMO, HODs, and local administrators meet every 6 months to review cataract surgery outcomes, including endophthalmitis, across the network. A 4-fold reduction in endophthalmitis rate from 0.08% to 0.02% was observed in the Madurai hospital, whereupon the findings and technique were shared through web conferences with other hospitals. During the next 8 months, all surgical centers across AECS adopted this as the standard of care, first in patients undergoing cataract surgery and later in all intraocular surgeries. The endophthalmitis rate was analyzed across all 10 centers of AECS, in more than 600,000 cataract surgeries performed from January 2014 to May 2016, and later in a series of 2 million eyes operated between January 2012 to December 2018. The same reduction in postoperative endophthalmitis was noted from 0.07% to 0.02%. In 2019, of 316,167 cataract surgeries performed, 38 were diagnosed with postoperative endophthalmitis (0.01%).

Cataract surgical outcomes are tracked using cataract quality assurance software, which is linked to the internal electronic hospital management system. This software has been used to monitor outcomes in all hospitals since 2010. The software records basic demographic information and preoperative, intraoperative, and postoperative data for every AECS patient who undergoes cataract surgery. AECS then introduced a web-based portal that analyzes variations across hospitals and surgeons, and benchmarks outcomes and complications at a detailed level. The portal allows individual surgeons to compare their outcomes with fellow surgeons across the system. They are able to benchmark their outcomes with the best surgeon’s outcome (such as lowest complication rate, best visual outcome) and with the institution’s average.

The cataract quality assurance software forms the core, providing real-time feedback and multilevel reporting. A wide range of stakeholders including hospital and department heads, surgeons, quality managers, and nurses have tailored access to the data portal and to the information relevant to their work. The HODs conduct meetings with operating room teams, including surgeons, residents, and nurses, on a weekly basis, and a biometry team meets monthly to review and analyze the data, discuss any deviations in protocol or the need to modify protocols, and elicit ideas for improvement. Complication rates, reoperation rates, and visual outcomes are presented and discussed at these meetings. Besides surgical outcomes, outpatient consultation waiting time is tracked in real time.

Every month each surgeon, including residents and fellows, receives an email with a brief report on the number of surgeries performed and key outcomes. Additional, contemporaneous reports are available on the web portal, with filters for data elements that include time period, technique, type of intraocular lens implanted, and patient comorbidity and risk factors.

The performance and outcome data available to surgeons and HODs serve as a rich source for improving technique and systems. Near misses are self-reported on the web portal, along with an analysis of the management, care, and improvements that can be made. A senior consultant and
quality manager along with the team periodically review the safety incidents and near misses reported on the intranet. Surgeons who are outliers on surgical complication rate or outcomes are mentored and may have their surgical schedule adjusted to accommodate this.

DISCUSSION

Each of the 3 organizations discussed shares the key elements of a learning organization: 1) the people in leadership and in the workforce, who exchange ideas; 2) training and resourcing for change; and 3) information management in the form of benchmarking and data sharing. In the case of intracameral antibiotic injection, a new technique was identified to improve quality and safety, and was instituted within 1 to 2 years’ time (Table 2). The reduction in infections is evidence of the success of the programs; and there is an attendant cost savings as well.\(^\text{22-24}\).

Each organization also has unique elements to its learning system (Table 3). Sweden’s national registry is a model for how government agencies and physician societies can work together in a leadership framework to improve medical outcomes, and thereby reduce adverse events and its attendant morbidity and cost to society. The benefits of health registries to improve health outcomes and lower costs by enabling medical providers to identify and share best practices are well described.\(^\text{22,25}\) The national registry also provides the foundation for robust benchmarking whereas the physician societies use the data and share information and skills in national meetings.

KPNC and its single medical group exhibits close workforce engagement. Integration with quality, risk, performance improvement, and research professionals who are formally trained in these areas leverages synthesis of information in parallel, and the wide cross-sharing of information among the disciplines, regionally and throughout the national program. AECS’s detailed web-based portal for quality outcomes is accessible to all stakeholders. Performance and outcome data are available for surgeon-peers, for example, to compare their own results with their colleagues in the department and in other hospitals. This real-time sharing with transparency allows for the identification of individual- and hospital-level issues quickly and facilitates, with the help of mentoring and collective engagement by quality trained staff, a more rapid improvement cycle.

CONCLUSION

By committing to a culture of promoting collective learning, new and creative ways of thinking, and leveraging each provider’s personal investment, health-care systems can improve care delivery and set new benchmarks in quality, safety, service, and affordability.\(^\text{5,26}\)

Disclosure Statement

The author(s) have no conflicts of interest to disclose.
Financial Support
No financial support was received for this work.

Author Contributions
Neal H Shorstein, MD, participated in the acquisition and analysis of data, drafting of the final manuscript, and critical review; Per Montan, MD, participated in the acquisition and analysis of data, drafting of the final manuscript, and critical review; Mats Lundstrom, MD, participated in the acquisition and analysis of data, drafting of the final manuscript, and critical review; Lisa Herrinton, PhD, participated in the analysis of data, drafting of the final manuscript, and critical review, and submission. All authors have given final approval to the manuscript. Aravind Haripriya, MD participated in the acquisition and analysis of data, drafting of the final manuscript, and critical review.

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