

**NICHOLAS E. DAVIES AWARD 2010 PROGRAM
ORGANIZATIONAL HEALTHCARE
FULL APPLICATION**

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Section 1: Management

1.1 eCare System Planning

Electronic Health Record (EHR) implementation requires sound strategy, strong leadership, and collaborative governance over the life of the project. Sentara planned, implemented and proactively managed the EHR project (called Sentara eCare Health Network, a.k.a. “eCare”) over a five-year period, and freely shares its challenges and lessons learned. Today, eCare is a comprehensive EHR system that integrates hospitals, physician offices, diagnostic sites and pharmacies, allowing ubiquitous electronic documentation and communication in real time. By way of the “MyChart” patient portal, patients can review test results, renew prescriptions, schedule appointments, and find information. As a HIMSS Analytics Stage 7 organization, Sentara operates in a largely paperless environment. In 2009, Sentara was ranked the number one integrated health care network in the U.S. by *Modern Healthcare* magazine, and is the only health system named in the top 10 for 12 years. Sentara is listed in the *U.S. News and World Report* annual guide to America’s Best Hospitals. *Modern Healthcare* also honored Dave Bernd with the 2010 CEO-IT award.

Organization Strategic Goals & Objectives: eCare was the cornerstone to Sentara Healthcare’s strategic imperatives. In January 2005, Sentara executed a deliberate effort to instill collaborative EHR leadership. Sentara solicited input from its 18,000 employees and the local community in the planning, implementation and optimization phases of eCare execution. Based on a yearlong campaign, the Strategic Management committee announced the results—

- Vision: Be the healthcare provider of choice in the communities we serve
- Mission: We Improve Health Every Day
- Values: People, Quality, Patient Safety, Service, Integrity
- Goals: Be regional best and aspire to national top 10%. Transform care delivery. Pursue growth. Add value to the communities we serve.
- Objectives: Improve quality outcomes, patient safety, and embrace transparency.

eCare Vision, Goals & Objectives: In June 2005, the Sentara leadership introduced the eCare concept to the Board of Directors as “...the Gateway to Clinical Excellence”. At that time, the CEO challenged the organization to imagine an EHR system that could forever enhance care delivery and the community’s well-being. Throughout the life of the project, the Board enthusiastically supported the eCare concept and diligently challenged the eCare team with questions of accountability: What is eCare’s effect on quality and patient safety? What is eCare’s influence on the physician practices? How does eCare impact staff morale? Is the project on-time, on-budget and on-target to achieve the strategic imperatives? With the strategic EHR goals in place, the eCare team was able to develop a sound project plan with specific performance metrics and milestones.

Beginning in 2006, the eCare vision was refined over a period of months with input throughout the organization. The CIO was adamant that everyone understand eCare was an operations’ owned project—not an IT project. The eCare goals were to (a)

revolutionize inpatient and ambulatory care delivery, (b) develop physician/system integration initiatives, and (c) adopt the Institute of Medicine's "Six Aims of Care"-- Safety, Patient Centered, Efficient, Effective, Equitable and Timely.

Leadership & Governance: Sentara approached eCare from an organizational development perspective. Believing that success depends on user engagement, the project teams represented all stakeholders, including physicians. As shown in Appendix A: eCare Governance Structure and Project Management Office Organization Chart, several stakeholder groups oversaw the design, build, and testing of the eCare functions and features. The Executive Design Committee (EDC) was responsible for the EHR design and implementation decisions. The EDC was comprised of senior leaders from the hospitals and physician practices preparing for EHR adoption. After EHR implementation at their home site, operational EDC members transitioned to the on-going Executive Optimization Committee.

The Physician Advisory Group (PAG) provided the key physician leadership. The PAG is comprised of over 25 community physician leaders from the major inpatient and ambulatory specialties. The PAG was instrumental in vendor selection, software design, and eCare implementation. Much like Super Users, PAG members volunteered to share their experiences and make recommendations. Compensated for their time, the PAG continues to focus on eCare optimization. Each hospital and physician practice had a medical director who provided leadership and consulted with the medical staff during implementation. The hospital Physician IT Steering Committee and the Medical Staff Officers Council provided implementation oversight and direction. A Community Collaborative of independent practices provided consultation on community issues.

Key Stakeholder Involvement: Gaining consensus among key clinical and business stakeholders is critical to EHR adoption. In 2004, Sentara engaged all disciplines in determining the EHR requirements, vendor selection, eCare implementation and eCare optimization. Collectively, the stakeholders created "a day in the life of a patient" workflow scenarios. The scenarios covered the major patient flows from admission to discharge, from physician's office to lab. Each EHR vendor was required to present their proposal strictly on the Sentara created scenarios. Videotapes of the vendors' proposals were reviewed across the organization. By the time the eCare business case was developed, 3,000 caregivers and 1,000 physicians had viewed the proposals.

Needs Identification & System Acquisition: Prior to eCare, Sentara had disparate "Best of Breed" legacy IT systems. In 2005, after implementing a PACS and eICU system, the CEO challenged the organization to provide seamless electronic information conveyance across the system. Following painstaking EHR research and Total Cost of Ownership analysis, the Board decided that despite the inherent risks, transformation of care demanded a greater commitment to information technology. The CEO set a clear and purposeful vision for determining our EHR needs and system acquisition strategy. Understanding the risks of predicting the future of technology, the CEO was passionate about finding the right IT platform at the right cost. Under specific CFO guidance, our Process Improvement and Business Intelligence departments conducted a rigorous needs

assessment and cost-benefit evaluation. As a result, 18 key workflow processes were identified that could be enhanced through an integrated EHR system. In 2005, following a Computerized Physician Order Entry (CPOE) retreat, the Board of Directors approved \$237 M for the eCare program, which remains the largest and most complex project the Board had ever approved.

Business Case: The eCare business case was based on an 18-month due diligence research of the top six EHR vendors, site visits to best practices, and a rigorous ten year Total Cost of Ownership (TCO) model. The TCO considered clinical and financial data. The 2005 projected benefits to hospitals included: Improved nursing efficiency--\$5.2M; Reduced IT maintenance--\$4.2M; Reduced medical records/transcription--\$4.1M; Increased outpatient services--\$3.2M; Reduced length of stay--\$3.1M; Improved pharmacy process--\$2.9M; Reduced paper/storage--\$2.4M; and Other improved processes--\$4.9M. Benefits to the Medical Group and Home Health totaled \$2.7M each. Similarly, the projected Health Plan benefits were \$2.8M. The total \$35.5M in benefits assumed a full implementation with 5.5 years, 90% paperless, and 90% CPOE.

Marketing & Communications: Sentara marketed the eCare vision, goals, objectives and progress extensively. Marketing activities included advanced demos, widely distributed tent cards, posters and gifts. We also conducted multiple MyChart community focus group sessions. An exclusive eCare employee portal provided daily updates. Each hospital identified celebratory themes for its EHR implementation and celebration.

Project Risk Management: To identify the risks of implementing the EHR, Sentara conducted site visits to several early adopter health systems, attended state and national conferences, solicited guidance from reputable consultants, conducted extensive literature review, and vetted multiple vendors. Based on a pre-defined Project Charter and Implementation Plan, the eCare Project Management Office (PMO) conducted weekly meetings to monitor the project plans, budgets, and user impact analysis. Internal auditors to the PMO provided the final approval on each hospital go-live. The PMO identified several potential high-risk processes as briefed at regular intervals by the application Design-Build-Validate (DBV) teams.

1.2 eCare System Implementation

Implementation Planning: With strong Board and medical staff support, the eCare leadership decided to pursue a Big Bang implementation to provide a single-view access for integrated results retrieval across all environments of care. Its features include computerized physician order entry, access to protocols, decision support tools, and clinical documentation built on architecture to facilitate patient record integration. eCare software applications include Epic's inpatient and physician practice EHR, pharmacy, health information management, emergency department, oncology, bed flow management, and scheduling. Supplemental applications include bar-coding, faxing, and patient health record. eCare used Six Sigma methodology to redesign 18 major workflows. A phased implementation approach was used with the philosophy of "build once, roll many".

The following dates list the major milestones:

June 2005	Sentara Board approved EHR funding
September 2005	Signed contract with the EHR vendor (Epic)
November 2005	Conducted Six Sigma initiatives
May 2006	Conducted Design, Build, and Validate
August 2007	Implemented five pilot physician practices*
August 2007	Implemented centralized scheduling and limited functionally in all Emergency Dept.
February 2008	Implemented pilot hospital*
November 2009	Implemented last of six hospitals
December 2010	Implement last of Sentara physician practice

* The physician practice pilot phase lasted six months to identify and resolve any issues. Afterwards, we implemented one practice every two weeks through 2010. The original hospital Plan A was to roll one hospital at a time on the Epic release Spring '05. However, Sentara decided to delay the pilot hospital by three months to install the new Epic release Spring '07, which had many clinical enhancements. Moreover, Plan B accelerated the rollout plan to minimize the monthly \$3 to \$4 M-dollar burn rate. As shown in Appendix B, the pilot hospital implementation included an extended support timeframe to allow a delayed CPOE ramp-up. CPOE started at go-live for the remaining 5 hospitals. Future eCare phases include hospital and physician practices billing and registration, as well as home health and long-term care. Sentara Obici and Sentara Potomac hospitals are not fully on eCare because they were acquired after the eCare project was approved.

Implementation Staffing: To instill operational ownership, Sentara recruited the eCare team from operations, when possible. Moreover, the preferred strategy was to train IT skills to clinical professionals rather than train clinical workflows to IT professionals. At the peak of accelerated Plan B implementation activity, the eCare team consisted of 190 FTE's—73 more than the original Plan A. The implementation staff was the same as the planning phase staff. To minimize disruptions to patient care during the implementation, the hospitals backfilled their staff with agency and nurse pool personnel. The hospital and practice physicians were supported at the elbow by a cadre of “black shirts”.

Training & Support during Implementation: The eCare project included the implementation team, training team and DBV teams along with Super Users (1:5 staffing ratio). The implementation training strategy was based on vendor guidance and principles of adult learning. End users were required to complete classroom training and pass a proficiency test to gain sign-in eligibility. The training content was limited to “just enough and just in time”. EHR demonstrations, job shadowing, and role specific workflow guided practices maximized user competency. Hospital employees were assigned by application type. The physician practice training sessions were grouped as administration, nursing, and physician. Whereas, the 12-hour hospital physician program was targeted on a need to know basis: 4-hours of view only, 4-hours of documentation, and 4-hours of order entry training. Allowing managers to enroll their staff via the

Learning Management System and providing Continuing Medical Education credits were helpful in gaining broad participation. Course attendance and proficiency test results were the key measures of training effectiveness. We also monitored the no-show and room occupancy rates, and the trainer-to-trainee ratio. During the weeks of hospital go-live, trainers augmented the implementation team's 24-hour support on the units. The DBV teams operated the command center help-desk phones.

1.3 On-going Operation of the eCare System

Management Policies & Procedures: eCare leadership continues to track and report results on a quarterly basis. In 2008, Sentara installed a 3-person optimization team at each hospital to (a) enhance MD adoption, (2) assure the business case, and (3) achieve additional benefits. The optimization teams report to the Executive Optimization Committee to monitor progress, resolve issues, and remove barriers. The EOC also reviews potential projects and prioritizes resources.

Impact on Operations: In 2010, we have more benefits than anticipated. Expecting a slow learning curve to adoption of best practices, we planned for 50% of the fully realizable benefits in the first year of go-live and 75% the year after. Although we planned \$16 M of benefits, we achieved \$36.5 M in benefits in 2009.

Remaining Paper Medical Record: Paper portions of the medical record maintained during or after the patient encounter include the consent forms, driver's license and insurance verification. All documents are scanned into the record within 24 hours.

Ongoing Planning: Winning the HIMSS Analytics Stage 7 Award was a stirring recognition of success. The COO/CIO presented the Stage 7 plaques at each hospital where operations' commitment, efforts and results were recognized. We believe that much more is possible. Based on eCare success, Sentara has committed \$12 M each year to further IT enhancements, clinical improvements, and informatics development.

Ongoing User Support: eCare Application User Groups manage enhancement requests. The Executive Optimization Committee approves all enhancements. The 24x7 general and physician help desks provide ongoing support. Each hospital VP for Medical Affairs determines the procedures for dealing with infrequent physician users. Infrequent physician users can dictate and/or scan written documents into the electronic record.

Ongoing User Training: Human resources orients new hires. eCare Optimization teams and department Super Users provide training for new enhancements and upgrades.

1.4 Challenges & Lessons Learned:

- Develop and gain commitment to a compelling vision of the future
- Manage cost and benefit expectations as costs will far outweigh benefits for 5 years
- Map benefits to processes and hold process owners accountable
- Embed the benefits in performance goals and budgets
- Leadership support is vital and operations must "own" the project
- Optimization ensures benefit realization, but operations has to own it
- Implement supporting systems to the EHR ahead of time (scanning/scheduling)

Section 2. Functionality

2.1 Targeted Processes

Processes & Provider Roles: The order entry process was redesigned and automated via the computerized physician order management (CPOE) application. This included all orders in inpatient and outpatient settings as well as physician office practices. Physicians enter and manage approximately 90% of all orders directing care for patients. The physician advisory committee (PAG) led the design of CPOE. The PAG consists of over 25 physicians from multiple specialties. The physician members are largely responsible for making the difficult design decisions. As a system, Sentara has an 87% CPOE rate for inpatients. CPOE adoption rates started above the 80% threshold at each hospital implementation. The last two hospitals started out at greater than 90% CPOE.

CPOE significantly reduced turn around time for order processing and patient care delivery. The average time for administration of a NOW medication dose after order creation was reduced from approximately 90 minutes to 30 minutes or less. Order sets are standard across the system and are evidence-based. CPOE eliminated the ambiguity of written orders. Clinical decision support tools, such as medication alerts, have reduced the need for nurses and pharmacists to validate orders through callbacks. CPOE supports the Institute of Medicine's "Six Aims of Care".

Streamlining of Clinical Care Processes and Documentation: On-line documentation has streamlined clinical care processes. Nurse care-plan content now drives clinical best practices among all inpatient disciplines. Interdisciplinary clinical staff evaluated several approaches for care plan content. They decided to utilize CPMRC® (CPM Resource Center) evidence based clinical content for the interdisciplinary care planning and clinical documentation. CPMRC® is an international consortium of more than 100 clinical settings that provides evidence based content with ongoing review and revision of clinical standards. CPMRC® methodology has initiated the transition to a truly integrated patient record that reflects care provided from all disciplines. Today the medical record reflects the patient's story of care, rather than the discipline's interactions with the patient.

Implementation of Medication Administration Barcode Scanning: Point-of-care barcoding radically redesigned medication administration. Nurses scan the patient, the medication and themselves to ensure closed loop medication administration. This workflow facilitates communication and cooperation between nursing, pharmacy and information technology staffs. We continually measure compliance with patient barcode scanning and medication administration. We analyze and follow up on the reasons for near misses and failed scans.

Overall Staff Response: Sentara has a 96% compliance rate for patient and medication scans. There were 12,459 (1.53% of all medications administered) potential medication administration errors prevented in March 2010 because of the medication barcode scanning process. The nursing staff has accepted barcode medication administration scanning as a significant safety improvement. It has brought their documentation process to the bedside where they can focus more on the patient. Barcode administration scanning

has improved safety, timeliness and has revolutionized the way nurses administer medications.

Changes to Patient Flow, Care Management and Length of Stay: Sentara redesigned patient flow and care management processes to enable real-time communications of patient status, bed need and bed availability. A “pull” process allows staff to direct the patient to the appropriate bed on a given unit without a central staff intervention. Length of stay is visible to caregivers on the patient banner, increasing awareness of actual vs. expected length-of-stay. Medical Care Management staff pushes data on patients awaiting placement out to long-term care facilities, which facilitates better handoffs and information transfer. The redesign of the workflows brought representatives from many inpatient disciplines. Their efforts resulted in a 16,000 patient day length of stay reduction and a reduced turnaround time for bed availability from ED to inpatient of 90 minutes.

Changes to Medical Records and Coding Processes: A commitment to real-time documentation and scanning capability have transformed EHR and coding processes. The EHR supports all care decisions. Paper generated from diagnostic equipment not interfaced to the EHR is scanned real time to assure it is available to caregivers. No paper charts remain in medical records departments. Medical records realized a \$3 M dollar reduction due to the paperless environment. There has been a \$1.4 M reduction in transcription costs and malpractice premiums. Claims denials have decreased by \$500,000 annually. Medical records departments now require minimal hospital space.

2.2 Information Access

Comprehensive Data & Data Capture: eCare captures and retains data from all critical systems that contain electronic clinical information. The EHR receives and stores all cardiology, vascular and pulmonary studies, laboratory results, surgical summaries, and radiographic interpretations and images. Interfaced information, such as handwritten orders, is scanned into the patient’s record via the document management system. All data elements are retrievable on an episodic, longitudinal and cross episode basis.

Sentara makes extensive use of point-of-care testing devices. Point-of-care testing devices can perform up to 24 discreet tests. Two-thirds of those test results are sent electronically into the EHR via Sentara’s enterprise laboratory system. Care providers enter the remaining point-of-care test results into the record as discreet results. eCare does not accept point-of-care testing performed by individual patients (e.g. home glucose testing). Where appropriate, patient collected data logs are scanned into the record or referred to in the progress notes.

Sentara adopted standard orders, order sets and documentation templates to ensure efficient data entry in a format that conveys data across all venues of care. Automation provides checks and reminders for data entered incorrectly; for example, alerts fire for incorrect medication dosage if the value is improperly entered or if a flowsheet cell exceeds or falls below specific thresholds for the patient’s age.

Physicians are not required to type notes such as history and physicals and discharge summary. They have the option of dictating these and procedure notes for transcription. Once transcribed, notes are filed in the EHR with prompts for electronic signature. The use of voice recognition technology has been successful in the Sentara physician practice setting and has helped to reduce transcription costs.

Sentara has employed the use of interface technology to make flowsheet documentation of bedside monitor and ventilator data more efficient for its nursing staff. Bedside monitor device integration (BMDI) is deployed in the critical care units, emergency departments, obstetrics, and endoscopy suites. As the EHR receives data, nurses are prompted to review the data for appropriateness before filing them on the flowsheet. Sentara has realized a CPOE rate of greater than 87%. However, a non-physician order entry process remains for a small number of verbal (9%) and handwritten (3%) orders. Non-physician clinical staff can enter verbal and handwritten orders. Verbal orders are co-signed electronically by physicians. Handwritten orders are scanned into the patient's record. Pharmacists compare the scanned handwritten medication orders to the orders entered into the system during the verification process to ensure transcription accuracy.

Information Availability and Ease of Access: The cross continuum EHR and CPOE process ensures that a complete picture of the patient's medication history and profile is available at each level of care. A medication reconciliation tool provides prescribers in the hospital environments a display of medications the patient was taking at home, including prescriptions created in the physician practice or emergency department. This list allows the prescriber to continue the medications in the inpatient environment or to hold them for a decision on whether to continue them at discharge. The list can be reviewed, along with the active inpatient medications, at the time of transfer to each level of care. Using the medication reconciliation tool, inpatient medications can be converted to outpatient prescriptions or discontinued at discharge

ePrescribing provides the ability for the physician practice prescriber to check the patient's medication history within the EHR provided by the claims processors. While the information is limited by whether the patient's payor participates with Surescripts / RxHub system, it can give the prescriber information about patient compliance. The increased ability to track and act on a more complete medication history as well as the medication barcode scanning process has provided significant improvements in ensuring a safe medication management system.

The EHR allows unprecedented access to the patient's charts across all venues of care except home health and long-term care environments. Non-Sentara providers who send patients to a Sentara facility for care or testing have access to the Sentara EHR for retrieval of clinical data. Consolidation of clinical data into a single source offers care providers clinical data that has never been available electronically. The key to accomplishing this integration was the implementation of an Enterprise Master Patient Index prior to the EHR implementation. These successes have led Sentara to investigate further integration opportunities with home health and long-term care, and non-Sentara EHRs.

2.3 Decision Support

Tailored Information Integration: To accommodate the variety of user types and disciplines afforded access to the EHR, Sentara created unique user templates to facilitate workflows. The Sentara EHR uses workflow components called “navigators”. The navigators guide the end user through the most efficient process for specific workflows (e.g. admission, transfer, discharge, clinic visits, etc). In addition to providing efficient processes for data entry and retrieval, the navigator helps ensure standardization of workflows and consistent data capture. Customized data retrieval templates show combinations of clinical data appropriate for specific providers and venues of care. Streamlined “View Only” templates are available for providers with limited data retrieval needs.

Decision Support: Sentara has a long history of developing and customizing algorithms for clinical decision support, specifically related to medication therapy. The focus of these efforts has been to reduce the number of unnecessary alerts while increasing the number of appropriate alerts. Inpatient physicians see medication alerts for drug-drug interactions, drug-allergy, maximum dose and pregnancy / lactation. Recent data analysis demonstrated that 23% of the time the physician providers took action when these alerts appeared during order entry. This result is higher than the 1% to 15% alert acceptance rates reported in the literature. The success Sentara has achieved in this area is due to customization of the vendor supplied external alerts logic within the EHR application.

The EHR also provides formulary substitute alerts. These alerts direct the prescriber to the appropriate choice of medication based on pharmacy and therapeutics committee decisions. Sentara has taken a cautious approach to the implementation of alerts and reminders to avoid compromising adoption. Many medication alerts are utilized (e.g. duplicate therapy, drug versus laboratory results, drug versus disease state, etc.) by pharmacists to ensure safety while not overburdening physicians with alerts. Other disciplines have taken advantage of the alerts and reminders. For example, alerts are in place for nursing staff to help ensure compliance with immunization protocols. Nurses and clinicians can use custom columns on their patient lists to display specific values when thresholds are exceeded. This functionality affords a quick and high-level overview of specific conditions over a large population of patients.

Order/Clinical Practice Standardization: Clinical decision support tools that take on a more passive role in the EHR include order sets, care plans, patient education templates, navigators, patient level customized views of clinical data, and cascading flowsheets. These tools help to standardize care, based on best practice and provide information relative to the patient’s conditions at the point-of-care. Requests for decision support functionality typically come from user groups and quality-related committees. A new clinical decision support committee was formed to provide a more formal governance structure for the development and management of clinical decision support.

2.4 Workflow & Communications

Provider Communications: eCare has revolutionized communication conveyance among caregivers. The Sentara EHR system has an internal messaging system that is at the core of communication between providers and patients. The internal messaging system manages the processing of unsigned documents, provides reminders to physicians regarding chart deficiencies, and sends information about abnormal laboratory results. Nurses can notify pharmacy to replenish medications. It allows direct communication between physicians and nurses in the practice setting, facilitates communications between patients and physicians via the patient portal, and direct communication among providers.

Knowledge Access & Patient Decision Support: The method for providing context sensitive information to the providers has changed because of the EHR. Medications have associated hyperlinks which, when selected, will refer the provider to a drug database containing information specific to the medication selected. Work is ongoing toward bringing disease-specific references to ICD-9 diagnoses displayed in various sections of the medical record. Links to clinical evidence and protocols are provided within specific order sets. The use of interdisciplinary care plans helps facilitate communication among care providers within a common space in the patient record. See appendix I. Workflow information Nursing Before and After.

2.5 Data Sharing with Other Organizations and Patients

EHR implementation has opened many possibilities in the way of data sharing. Sentara sends data to state and national registries such as the Essence Health Report project, the CDC Biosense database, and the Virginia Department of Health. Care providers and medical records staff can route patient summary data to the next provider(s) of care via facsimile server from within the EHR when the patient is to be seen by a provider not on EHR. The patient portal is proving to be an important mechanism for communication between the patient and the physician. The portal allows the patient to view physician-specified test results; request and view office appointments, request prescription refills, access disease and medication reference materials and communicate via internal messaging with their physician. Future functionality will likely allow patients to enter medical and family history data for assimilation into the record by the care providers.

2.6 Secondary Uses of eCare Data

The Sentara EHR integrates with the external hospital and practice management registration and billing system. Patient charges originated in the EHR flow via HL7 interface to the hospital and practice management systems. A significant portion of charges generated in the EHR is the by-product of clinical documentation. This ensures greater accuracy between the patients' bills and the clinical documentation. Moreover, the EHR has led to significant clinical and quality report development. Sentara improved its quality measures since the EHR implementation, due to the ability to monitor compliance and make appropriate interventions. Real-time reports are used to identify patients who may need interventions to assure quality and safety compliance. Staff and leadership use historical reporting to analyze and report management, quality and safety data to internal and external stakeholder groups. As a non-teaching hospital, Sentara is minimally involved in clinical trials and research initiatives.

See appendix J. Key Performance Indicator Reporting.

Section 3. Technology

3.1 Scope & Design of eCare System

Servers: The eCare platform supports 3000 end users employing a mix of Windows and UNIX server technologies. At the heart of the multi-tier server architecture lays the primary and failover UNIX database servers. These servers are equivalently architected Hewlett Packard (HP) Titanium Superdomes containing 12 Titanium 1.5GHz processors, 32GB of physical memory and run HP-UX version 11iv2 for their operating system. These servers deploy an Intersystems Cache database shared among all eCare applications. In the event of hardware failure on the primary database server, failover to the second database server can occur within 10 minutes. The average Central Processing Unit (CPU) utilization on the database server during peak load is 25 percent. Ten HP Titanium RX26600 servers handle the application-processing layer, each containing four processors, 16GB physical memory and running HP-UX 11iv2 for their operating system. Utilizing Intersystems Enterprise Cache Protocol (ECP), application processing is separated from backend a database process that provides the ability to scale the platform by adding application servers.

Production data is replicated to three other HP Titanium Superdomes UNIX servers. One server acts as a read-write copy of the database and is used in the event of a catastrophic failure on the primary storage hardware. The second server is used as a reporting server, which provides analysts and end-users with the ability to query production data in near real time. This offloads reporting requests from the production database. The third server provides a read-only copy of the database. During system maintenance, eCare users have read-only access to the production data. Replication between the production database and the three shadows occurs by utilizing the shadow functionality within the Intersystems Cache database. Latency between production and the shadow servers averages around 15 seconds during peak utilization. All servers hosting critical functionality are architected in a redundant fashion. No single server component or complete server failure will cause system unavailability. See Appendix C. for the diagram of the physical layer network configuration for eCare Health Network

Storage: A HP XP12000 with 3TB of usable Raid 10 disk space and 36GB cache memory provides storage for the production database server.

Desktop: Epic is deployed to 11000 desktops utilizing Citrix 4.5 running on x86 OS platform. Our Citrix farm includes 70 dedicated servers for the eCare environment. Using Citrix servers allows quick additional capacity without software loads on individual desktops.

Remote Access: Remote access to the EHR environment for physicians is provided using the Citrix solution via a web portal. MyChart provides a patient portal to the electronic health record. Patients have access to portions of their medical record by their primary care provider. MyChart is hosted on a pair of load balanced HP Windows servers. As of May 2009, more than 20,000 patients have MyChart access. Additional practices are added monthly.

Interfaces / Integration: The EHR system shares a single database that integrates patient clinical and financial data from all Sentara medical groups, hospitals, labs, and soon, non-owned community physician groups. New functionality will soon allow other Epic and non-Epic sites to share patient's clinical data in real-time. While eCare has replaced many of the legacy systems within the Sentara enterprise, some of the ancillary systems and medical devices remain in the organization. See Appendix D for Sentara eCare integration diagram.

Interoperability: Sentara eCare Health Network is integrated with most clinical systems within the Sentara enterprise and shares information with other agencies. Sentara has licensed the Care Everywhere application from Epic that allows Sentara to share clinical data with any other Epic hospital in the nation. We have also licensed the Care Elsewhere application that allows Sentara to share clinical information with other non-Epic EHR systems. Currently Sentara is sharing Emergency Department data with the Center for Disease Control (CDC) in an effort to assist the CDC in monitoring and detecting any outbreaks. Sentara also has a current initiative to extend our EHR to community physicians to use in their practices.

Customization/Optimization: During the design phase of the project, Sentara identified and applied several principles to drive decision-making regarding standardization versus customization. The principles include (a) apply vendor-recommended best practices as the standard, (b) simplify work and minimize hand-offs, (c) enter information once, share many, (d) maintain common look and feel for all modules, (e) eliminate loop-holes, use system as designed, and (f) apply 80/20 rule. These principles were used to aid decision-making groups at all levels, including the Executive Design Committee. Today, Sentara has Optimization teams in both the ambulatory and hospital environments, which continue to apply these principles.

Scalability: By using Citrix we can deliver a fully functional application / client via the web when external and on the desktop PC when local. As more users require access to the application, we are able to add servers to support the additional load. As updates are needed, we are able to patch the servers at our data center, which patches the client the next time the user launches the application. When the user load is low, we are able to pull servers out of the mix and update them, then put them back in after the updates to reduce user downtime.

Emerging Technologies The eCare system staff and management evaluate emerging technologies on an on-going basis to assure that the system can accommodate new technologies and devices. The infrastructure team sets standards for all technologies. Additionally, mobile device technology teams have been formed to evaluate how to incorporate new technologies into eCare.

Data Warehouse: Sentara is moving its enterprise informatics strategy to a consolidated enterprise warehouse model. Sentara's strategy brings clinical, financial, operational, human resources and materials data together to allow a broad array of analysis such as clinical quality and outcomes, costs, efficiency and predictive modeling. The clinical

repository stores information from our primary EHR. The EHR, materials management, and surgery data extracts are nightly. More frequent extracts are performed on real-time key indicator data. This information is matched with accounts receivable data, which is extracted on a weekly basis. Benchmark information from industry vendors is incorporated allowing for external comparisons. Clinical information will be extracted from other ancillary systems in future phases. Sentara's technology architecture is primarily the Microsoft BI solutions.

We use MS/SQL server as the primary database, MS/SSIS as the ETL layer and MS/Analytical Services as the OLAP layer. For analysis we utilize active MS/Excel spreadsheets and Performance Point for key performance indicators. There are analytical tools such as SAS and SPSS for high-end analysis. Business Objects is used for general reporting in some clinical environments. Sentara has instituted enterprise informatics data governance whereby standards are identified, use and access are defined, and data are assessed for integrity, reliability and value. Transparency is a foundation whereby any Sentara entity can benchmark itself against other like units within Sentara and against industry competitors. Cross continuum of care analysis is being incorporated into the informatics strategy that allow analysis from the physician's office, hospital setting, home care, long-term care and health plan. The analysis will focus on population and disease management and provide information on appropriate care delivery.

Network

- 133 Sites
- 333 Communication closets
- 2,369 Networking Devices
- 5,024 Wireless Devices
- 29,979 Customer Devices
- 33,588 Voice Devices
- 290 miles of fiber between hospitals

3.2 Security & Data Integrity

Security: To protect privacy and confidentiality, Sentara implemented a role based security model for the EHR. Each user type is built to include only the security functions necessary to perform their job duties. The training curriculum is tailored to this role based model to ensure employee competency. The eCare security team performs quarterly audits and reviews all active users to validate that they have the appropriate security for their job role.

Confidentiality: Sentara requires employees and non-employees to sign a statement of confidentiality and complete integrity training on an annual basis. The confidentiality agreement states that employee will only view patient data specific to the patient care requirements. A privacy hotline is in place to report suspected security breaches or inappropriate use of the system. During the breach investigation, the eCare security team will run Clarity audit reports on the patient record, perform a full chart audit, and forward to the Privacy Officer for review. If a breach did occur, the appropriate level of disciplinary action is taken, up to and including termination.

HIPAA Compliance: Sentara has implemented the HIPAA requirements related to patient data and the EHR. This includes, but is not limited to:

- Developed a security breach process, privacy hotline and security awareness.
- Developed a role based security model and user access control automation tool.
- Performed a full risk analysis of all workstations, and created workstation time outs.
- Developed and required a Business Associate agreement for all business associates.

Data Quality and Integrity: Sentara's EHR Technical services team runs daily integrity checks on the production database.

System Integrity & Disaster Recovery: Sentara uses multiple technologies to protect system integrity and provide disaster recovery. Some options are hot stand-by systems, fault tolerant systems, or using clustered systems. Sentara contracts with SunGard for Disaster Recovery services.

Data Archiving and Storage: Sentara uses the latest technology for SAN and Archiving solutions.

3.3 Standards

Common User Interface Standards: User's of the eCare system, at Sentara Healthcare, have a consistent presentation of the Epic application, whether they are viewing the application from their physician practice, from the hospital floor, or from their living room.

Data Model: The eCare system has a centralized database that serves both the ambulatory and hospital-based users of the system. The eCare system employs Smart Tools that allows for standardization of terminologies and maintaining data definitions. Smart Tools contain pre-configured text that can be used to standardize documentation, such as notes, within the system. SmartTools include SmartLinks, SmartLists, SmartPhrases, and SmartTexts.

Standards: Whenever possible, patient data are entered or interfaced into the eCare Health Network database. The data in the eCare Health Network is either entered directly or electronically interfaced using a Health level 7 (HL7) feed from other third-party systems. Interfaced data, utilizing the HL7 protocol, includes lab results, imaging results, medical device data, transcriptions, pharmacy, and any scanned documents, including inbound faxes. Interfaced data allows the eCare Health Network to provide a complete clinical display to the care provider from a single platform. The integration of the data and workflows increased the efficiencies of handoffs, interdependent departments, and independent applications.

Sentara's integrated model has benefited patients by allowing them to access certain clinical information and schedule certain appointments using the MyChart product. Improved Prescription eligibility results when benefits are validated real-time using RXHub. The actual script is sent electronically to a pharmacy of the patient's choice allowing the patient to pick-up the medication with little or no wait.

3.4 Performance

Availability: eCare is a fault tolerant/redundant system. It is designed to not have any point of failure. There is also a fail-over database server. The cache shadowing process keeps copies of production on the Clarity Shadow, the Read-Only Shadow, and Read-Write Shadow. The Read-Only shadow is used for scheduled downs; the Read-Write shadow is available in case of hardware failures.

Response Time: Response time on the eCare system is monitored at several levels. There are robotic probes that measure Citrix initiation and login response time. These probes page on exceptions and send out daily management reports. A Response Time Tracker monitors specific workflows in Epic Hyperspace, and both Sentara and Epic review response time. To address specific response time user complaints, we install Epic Instrumentation on the workstation and track exceptions and pinpoint causes.

Service Level Agreements: Service Level Agreements are set up for various components of eCare, including system response time, disk read/write speeds, backup and recovery mechanisms, and disaster recovery, etc.

Continuity Planning: The eCare system has built in several mechanisms to account for system outage or network outage. In the event that the entire system is unavailable, we have a separate Disaster Recovery Shadow server to keep the system functional. Sentara has also contracted out to SunGuard for offsite disaster recovery readiness. In the event of a Wide Area Network (WAN) outage, the eCare system has Business Continuity Access (BCA) web servers at each hospital facility that contains patient lists and schedules that are updated throughout every day. In the event of a Local Area Network (LAN) outage at a facility, the eCare system has BCA workstations at every department in the hospitals and every practice in the ambulatory sites. These BCA workstations also contain patient lists and schedules that are updated throughout every day.

For additional Technical downtime, Business Continuity and Disaster Recovery information see appendix K.

Section 4. Value

4.1 Documenting the Actual Value eCare System Serves

For the year 2009, we have documented ROI (return on investment) and VOI (value of investment) benefits far in excess of what we anticipated. We expected a learning curve to slow adoption of best practices and to make benefits achievable at only 50% of the fully realizable benefits in the year of go-live and 75% the year after. With those expectations, we put \$16 M of benefits into 2009 goals and budgets. As we analyzed our monthly scorecard, we were amazed that the benefits were being realized at a much faster pace than anticipated, and by year's end, our annual scorecard showed that we had realized more than \$34.5 M in business case benefits in 2009. We recognize that many of these benefits are due to "eCare being bigger than Epic" and are attributable to the combination and interaction of the EHR, Scanning, Barcoding, and process improvements. Moreover, the operational leaders' commitment to, and accountability for achieving the benefits has made a huge difference in Sentara's bottom line and in quality, safety, throughput, and satisfaction measures.

In addition to the business case, we understood there were many more benefits to be realized. We have already identified an additional \$2.8 M in benefits not included in the business case, and we expect there to be opportunities to achieve other benefits, which would not be realizable without a solid foundation of EHR, Scanning and Barcoding. Our goals to transform care are aggressive, but we are confident that the technology and process changes we have implemented through eCare have provided Sentara with a foundation upon which to build truly transformational redesigns.

Below is a summary list of key benefits realized in 2009. These benefits provide compelling arguments for implementing major technology and workflow process changes.

Streamlined Care Processes and Enhanced Medication Alerts:

- 88,500 potential medication errors were avoided due to bar-coding scanning alerts
- 7 of 10 emergency departments improved their triage performance; 4 of 10 EDs improved their admit time performance and all hospitals improved their patient throughput times. The median percentage for 14 of 14 patient flow metrics improved and for 8 of the 14 patient flow metrics, the median improvement was greater than 25%
- Percentage of patients with angioplasty within 90 minutes of arrival increased from 78%, (Q1 2009 to 90%, in first quarter of Q1 2010
- Percentage of outpatient surgery patients who had antibiotics started within 60 minutes of incision increased from 84% (Q1 2009) to 92% (Q1 2010)

Ordering Process

- CPOE reduced medication order entry to administration time from 59 minutes to 4 minutes

- CPOE and medication barcoding decreased time from order written to medication administered (NOW orders) from 132 minutes to 38 minutes.
- Elimination of duplicate orders reduced inpatient lab tests by 5.5 %
- Decreased Length of Stay
- Decreased Adverse Drug Events

Medical Records

- SMG transcription, medical records and malpractice premiums reduced \$1.4M
- Hospitals' medical records savings of \$3.9 M due to paperless environment

Efficiency Benefits

- 190 FTEs have been redirected to more value added activities
- \$9.4 M in savings due to reduction in nursing overtime and purchased labor
- Increased outpatient revenue by \$4.4 M due to being “easier to do business with”, which has led to an increase in outpatient procedures.

Length of Stay Improvements

- \$9.4 M in length of stay savings due to streamlined care processes
- Health Plan realized \$2.2 M due to reduction in severity-adjusted length of stay

Turnaround Times

- The time from bed assignment to admit an ED patient has decreased 90 minutes
- Central scheduling average speed to answer was reduced from 71 to 10 seconds and the abandonment rate was reduced from 9% to 3%

Quality Improvements

- Readmission ratios reduced at each hospital, by 5% to 18%
- Compliance with influenza/pneumonia immunizations enabled Sentara to identify the epidemic had passed before the State did and to notify the State
- SMG implemented Physician Quality Reporting Initiatives in primary and specialty practices
- Sentara's CMS core measures % of green metrics doubled from 36% (Q1 2009) to 72% (Q1 2010)

Miscellaneous

- 87% CPOE (Computerized Physician Order Management) for six hospitals
- 20,000 registered MyChart users have access to portions of their chart and electronic communications with their physician offices
- Risk Management Claims have reduced \$250,000 per year
- Denials have been reduced with an estimated annual savings of almost \$700,000
- Enhanced communications with and among physicians and ability to round from office or home have enhanced the timeliness of care decisions, (anecdotal input from physicians)

4.2 Success in Meeting Expectation of the eCare Project Goals, Objectives and Business Case

The EHR Journey Begins: In 2003, Sentara's CIO took a group of IT leaders, physicians and process redesign experts to the HIMSS annual meeting. The weekend before the annual meeting started, this group of 15 professionals met with six EHR vendors. The purpose of the meetings was to hear the status, progress and prognosis of EHRs to determine whether it was time to pursue an EHR strategy. The unanimous consensus at the end of the sessions was that it was time as there was sufficient evidence that an EHR would provide significant improvements to quality, safety, throughput and cost savings.

Upon return, the CIO assembled a cross functional committee to develop the strategy and a business case – called the eCare group. The eCare group split up assignments and conducted more in-depth research. The IT leaders in this group pursued the technology perspectives, to include site visits, on-site vendor demonstrations to a large group of operational leaders, phone calls to early adopters, and document searches for best practices. The process redesign experts pursued the business case benefits (qualitative and quantitative) for why Sentara would want to pursue this expensive and high-risk undertaking. They conducted document research, contacted best practices identified by the research and by whom the semi-finalist vendors had identified as doing the best job of implementing their EHR and tracking benefits.

Based on the original round of research, the eCare group made a presentation to Sentara Executives about the potential of an EHR. This presentation, titled “Imagine If,” presented a compelling argument why the time was right to invest in an EHR and identified the major processes where benefits are expected. Executives supported the strategy and encouraged operational leaders (process owners) of the most impacted processes to work with the group to help build the business case and evaluate the alternative EHR products.

The process owners became actively involved and spent considerable amount of time reading the research, talking with best practice organizations and attending demonstrations, and making site visits. Over a period of several months, they became comfortable with estimates of benefits, to include return on investment (ROI) and value of the investment (VOI) benefits. Eventually, they committed to achieve a certain level of return - once the learning curve was overcome, assumptions had been met and the EHR was fully functional. Their estimates became the basis for the business case presented to the Board of Directors.

Meanwhile, the IT leaders were conducting extensive research into the various vendors and eventually narrowed the potential vendors down to three finalists. They brought the three finalists in to do “scripted demonstrations” of the actual software, not PowerPoint slides of the software. There were more than 700 attendees at a multiple day demonstration. Attendees were asked to rate the vendors against specific criteria.

Total Cost of Ownership and Benefits: IT leaders, supported by Decision Support and Finance leaders, developed the total cost of ownership (TCO) 10-year forecast. This TCO was based on extensive research into the best practices for implementing an EHR across the continuum (hospitals, ambulatory sites and physician practices). The TCO was calculated for the three finalists, as were the benefits, so that the comparative business cases were evaluated as a part of the decision making process. To ensure the TCO and business case were realistic, a consulting firm with EHR experience was hired to conduct a thorough assessment and validation. The vendor validated that we were conservative in our estimates and identified an additional “cost of doing nothing” benefit that helped strengthen the business case.

The TCO and business case benefits were vetted by all the directors of finance from the various divisions, extensive number of operational leaders, and senior leaders of Sentara. Process owners presented the benefits to their counterparts in order to further refine and validate the estimates and expand the “ownership” of the benefits commitment. Draft TCO and benefits were presented to the CEO Work Group and the Chair of the Board in separate meetings to obtain guidance and commitment. These “pre-meetings” resulted in guidance to obtain additional benefits commitments from process owners as the initial estimates were too conservative. The TCO over 10 years, and the “upside down” costs versus benefits showed the magnitude of the effort:

Capital	\$ 67 M
Operating expenses	\$ 170 M
Hardware maintenance	\$ 15 M
Software maintenance	\$ 50 M
Disaster recovery	\$ 3 M
Work redesign	\$ 36 M
Training	\$ 16 M
Implementation	\$ 22 M
Ongoing support	\$ 22 M
Other non-salary support	\$ 6 M
Total Cost of Ownership over 10 years	\$ 237 M

The benefits (ROI and VOI) agreed to by process owners, Sentara executives and IT leaders in June of 2005 were:

Hospitals Total	\$30.0 M
Reduced Nursing overtime & improve retention	\$ 5.2 M
Reduced IT maintenance	4.2 M
Reduced Medical Records/Transcription	4.1 M
Increased outpatient services	3.2 M
Reduced length of stay	3.1 M
Improved pharmacy process/ADEs	2.9 M
Reduced Paper/storage	2.4 M
Other improvements	4.9 M
Home Health Total.....	\$2.7 M
SHP Total.....	<u>\$2.8 M*</u>

Sentara Healthcare Total.....\$35.5 M **

* 62% of Sentara Health Plan benefits will be passed on to employers

** Excludes \$2.7 M in Sentara Medical Group (SMG) benefits which will accrue to SMG physicians

Values of investment (VOI) expectations presented to the Board were:

- Provide one chart for patients with real-time information for all points of care
- Provide accessible charts anytime, anywhere to all providers
- Improve communication between nurses, PCPs, specialists, etc.
- Streamline medication process in hospitals, MD offices, home health
- Reduce illegible orders and wasted time due to handwriting issues
- Improve physicians ability to round for others from office/home
- Enhance recruiting and retention of MDs and staff
- Increase ease of scheduling in office, patient's homes, anywhere
- Eliminate duplicate tests which cause delays and unnecessary work
- Provide evidence based medicine alerts and reminders
- Streamline care management and discharge processes
- Optimize staff time by minimizing time spent retrieving patient information
- Improve reporting capability to help with research, pay for performance, etc.
- Enhance patient education and disease management programs

Summary of benefits presented to the board include:

- Improve quality of patient care
 - More efficient and effective care in all environments
 - Real time access to notes, results and best practices
- Bottom line:
 - Lives will be saved
 - Health will be improved

Sentara Board Approval: On June 27, 2005, the CIO presented the eCare concept, highlights of which are listed above, to the Board of Directors. His presentation included the reason for committing to an EHR, the TCO, the estimated financial benefits (ROI), value of the investment (VOI), the payback/return on investment, time to implement versus time to realize benefits. It also included how we would track early adopters to identify problems before we moved ahead. The overarching message to the Board was that the entire Sentara leadership team, not just IT, believed in the vision, was committed to achieving the estimated benefits and would use the TCO funding to transform care, not just “install an EHR.” The phrase “eCare is bigger than Epic” became a cornerstone for the entire project and remains a core principle to this day. The \$237 M TCO was the largest expenditure ever requested by Sentara’s leadership, and for the first time ever, an IT project included operational costs for process redesigns, designing the software and training for the major changes that would be required.

After the Board approved the eCare project, negotiations began in earnest with the vendor selected as providing the best continuum product with the highest level of benefits (Epic). The IT leaders began organizing their design, build, validate teams, identifying the number of additional staff they needed, recruiting and selecting the staff members. Almost all of those selected were from operations, since the CIO’s belief was that it was

easier to teach a clinician how to design an IT software system than to teach an IT professional the clinical processes which they would have to be changing.

Having signed a contract with Epic in September 2005, efforts to recruit, train and organize the project accelerated. Meanwhile, the CIO challenged the process redesign team to train members of the eCare team on Lean Six Sigma principles. In November of 2005, a three-day “foundations” class was conducted and more than 80 eCare members were trained in a common set of tools and techniques with which to redesign processes – and not just “install an EHR.” This was followed by a three-month “surge” where more than 200 leaders, facilitators, staff members and eCare members participated in very thorough and aggressive process redesign work. Meanwhile, the eCare team was getting trained, certified, and participating in the process redesign efforts.

Benefits Tracking: We are firm believers in the adage that “what gets measured, gets done and/or improved.” A key decision was made in January of 2007 that helped ensure benefits would be realized. In keeping with the notion that eCare is bigger than Epic, the Executive Design Committee (EDC) decided to use 2006 as the baseline year against which to measure the ROI. This decision, which was contentious, was based on three factors:

1. Having a complete baseline year where there were no Epic applications installed (applications began being installed in mid to late 2007).
2. Encouraging operational leaders to begin improving processes, which would help us either exploit Epic or achieve the non-Epic solutions. This decision was controversial, as many executives wanted to be able to separate out benefits for other initiatives and give credit for non-eCare related process improvements. The COO and CFO influenced the decision by stating that there was no way our organization would be able to sort out the separate benefits for various initiatives. To try to do so, would only add costs and we would not hire the numerous analysts to try to sort out “who gets credit.”
3. Preventing any possible “gaming of the system,” where some departments or divisions might inadvertently let performance slip in a benefit category, knowing that their baseline performance was yet to be measured and poor performance in the baseline period would make the expected benefits easier to reach.

In 2007, expected benefits by benefit category and by hospital were embedded in the 2008 goals for key executives and in divisional and departmental budgets. Working with Finance and Internal Audit to validate the way we planned to measure business case benefits, and communicating periodically (quarterly to semi-annually) with process owners, a scorecard was established and baseline performance measured (see 2009 eCare Benefits achieved on next page).

2009 eCare Benefits Achieved									
Unfavorable to 2006 Baseline		Red							
Favorable to 2006 Baseline		Yellow							
Favorable to 2009 Expected Benefits		Green							
Benefit Achieved 2009 YTD									
#	eCare Hospital Benefit	Process Owner	SLH	SVBGH	SBH	SNGH	SCH*	SWRMC*	Total
1-3	Streamline Record Completion	MS	\$189,272	\$154,045	\$70,337	\$544,853	\$52,850	\$298,969	\$1,310,325
4	Reduce Transcription Costs	MS	\$328,911	\$361,891	\$231,303	\$481,498	\$181,357	-\$183,430	\$1,401,530
5	Streamline Coding Process	MS	\$101,694	\$50,634	\$88,083	\$64,016	\$21,437	\$2,107	\$327,970
7	Reduce Risk Mgmt Claims & Uninsured Losses	FS	\$41,667	\$41,667	\$41,667	\$41,667	\$41,667	\$41,667	\$250,000
8,21	Reduce Length of Stay and/ or Reduce ADEs	GY/ TJ	\$2,106,369	\$1,548,283	-\$94,390	\$3,356,602	\$1,593,959	\$847,206	\$9,358,030
9	Reduce Paper Related Supply Costs	MS	\$254,523	\$371,985	\$58,840	\$381,759	\$102,800	-\$12,400	\$1,157,507
10,11	Increase Unit Efficiency/Retention of RNs	LK	\$696,326	\$594,022	\$46,314	\$3,956,180	\$3,674,625	\$421,571	\$9,389,038
13	Improve Charge Capture	AW	\$535,228	\$861,292	\$249,939	\$900,324	-\$25,144	-\$547,541	\$1,974,097
14	Reduce Payment Denials	AW	\$107,816	\$143,269	\$25,948	\$220,419	\$157,769	\$38,575	\$693,797
16	Reduce Inappropriate Admissions	GY	\$18,000	\$24,000	\$20,400	-\$1,200	\$10,200	-\$2,400	\$69,000
20	Increase Outpatient Procedures	AW/ KH	\$812,029	\$872,584	\$461,763	\$1,394,896	\$552,096	\$303,888	\$4,397,256
22	Reduce Pharmacist Order Entry	TJ	\$42,780	\$11,777	\$7,115	\$0	\$5,416	\$0	\$67,088
Cumulative Hospital Benefits			\$5,234,614	\$5,035,449	\$1,207,318	\$11,341,014	\$6,369,034	\$1,208,212	\$30,395,640
#	Annual eCare Benefits (2009 Achieved)	Process Owner							2009
12	Reduce IT maintenance expense	BR							\$1,858,212
14	Reduce Payment Denials	AW							\$0
-	SH-P Expected Benefits	AP							\$2,000,818
-	SE Expected Benefits	RD							-\$290,493
Total 2009 eCare Benefits Achieved									\$34,545,163

eCare Benefits in Addition to Business Case
2009 Q4 Benefits Achieved

#	Benefit	Hospital						Total
		SLH	SBH	SVBGH	SNGH	SWRMC	SCH	
1	Reduce IP Labs	\$196,993	-\$50,813	\$114,770	\$196,577	-\$36,038	\$39,499	\$460,987
2	ED Registration Staff	\$22,940	\$43,710	\$18,290	\$20,770	\$15,810	\$43,710	\$165,230
3	Order Entry/ AA Staff	\$311,201	\$125,552	\$405,246	\$676,556	\$184,718	\$331,009	\$2,034,282
4	Endoscopy Staff	-\$19,000	\$0	-\$20,500	-\$19,500	\$0	\$0	-\$59,000
5	Rehab Transcriptionist Staff	\$31,000	\$31,000	\$31,000	\$0	\$0	\$0	\$93,000
6	Leapfrog EMR Benefits							\$177,611
Total Additional eCare Benefits		\$543,134	\$149,449	\$548,805	\$874,403	\$164,489	\$414,219	\$2,872,110

Once the first hospital went live, we had daily meetings on various performance metrics so we could help operations track processes and identify potential problems before they became entrenched and difficult to root out. These measures, more than 40 of them, were around financial performance, throughput times and volume metrics. After three weeks, reporting was reduced to every other day, and then weekly, then monthly and eventually phased out as a monthly ROI scorecard began to be populated and process performance measured.

One of the most important metrics being tracked was barcoding performance. Medications barcoding, a major technology initiative on its own in most organizations, was the third major system implemented simultaneously (Epic EHR, Onbase scanning and Medications Barcoding all on day one). The only major change not implemented on day one at the first hospital was CPOE. That was phased in over the next several months, and in hindsight, that was not a model we would recommend nor did we repeat elsewhere as all subsequent hospitals went live with CPOE at go-live.

Another series of process metrics we tracked early on and still do is scanning performance. This was a process, at the first hospital, which had major performance issues and caused major problems with throughput and nursing/pharmacy processes. Being able to monitor performance daily, enabled process problems to be identified, a consultant brought in, fixes identified and implemented within several weeks post go-live. See Appendix L. Benefits Tracking for more information.

Another lesson learned is that the process redesign experts worked extensively with process owners, but did not work with the operational leaders/departments at the first hospital until only a few months prior to go live. We redirected process redesign professionals to other projects since we assumed that the process owners would ensure the go-live hospitals understood the process redesigns that augmented, changed and exploited the software. That naïve assumption changed about six months prior to go-live at the first hospital, and we worked with over 40 departments prior to go-live to help them understand/redesign their own processes. That worked well in all but three departments, where the magnitude of the changes exceeded our collective ability to get the departments ready for go-live. At go-live, throughput problems occurred in the three areas (Medical Records/scanning; Surgery; Endo). The good news is that through optimization efforts post go-live, fixes to processes were made, performance improved and future hospitals benefitted from lessons learned at the first hospital.

See appendix M. Beacon Oncology module implementation delay.

4.3 Success in Achieving Desired Change in Targeted Processes

Process Redesign efforts: The CIO also tasked the redesign professionals to work with operations and the eCare team to analyze core processes and redesign the processes to help ensure we fulfilled our promise to the Board of Directors that we would transform processes and realize the expected benefits. In January 2006, sixteen teams (more than 200 individuals) were committed to a three-month project to redesign Sentara's most important processes. The 16 processes, later expanded to 18, were selected by the Executive Design Committee (EDC), which had been created to provide the highest level of oversight and decision making to the eCare project. Most of the processes were those that had the most significant ROI, but several of them were ones where the only benefits were significant VOI improvements.

1. Arrival Management
(Registration, ambulatory testing order entry)
2. Bed Management
3. Case Management
4. Charge Capture
5. Claims Processing
6. Clinical Communications
7. Disease Management
8. Emergency Department
9. Home Health
10. MD Processes
11. Medical Records
12. Meds Management
13. Monitoring/ Recording
14. Order Sets
15. Patient Care Transformation
16. Patient/ Member Satisfaction
(MyChart)
17. Physician Practice
18. Scheduling

These 18 redesign teams committed several hours a week for three months to a Lean Six Sigma effort. The teams analyzed current processes, measured performance, identified problems and opportunities, and designed the ideal processes. The ideal processes were then sorted into four categories; (a) changes that would be taken care of by Epic, (b) those where we needed to do something to exploit Epic, (c) those where the changes had nothing to do with Epic, and (d) those changes which were a future improvement.

In late April 2006, these teams reported out over two days to more than 100 Sentara Executives, operational leaders, eCare team members, Epic product managers, and IT leaders. The eCare Design/ Build/ Validate (DBV) efforts commenced after the process redesigns were completed, and the team members had been to training at Epic. Over the next several months, DBV teams included many of the process redesign members to ensure processes were designed into Epic so that the benefits would be realized.

Meanwhile, most of the process owners, who had been the operational leaders/executive sponsors for the redesign teams, continued to engage their teams in designing and implementing solutions that would enable them to exploit Epic or non Epic improvements. In many cases, the teams learned through the redesign phase that many of the benefits would not be realized just by putting in Epic.

DBV, PAG and Implementation: Design/Build/Validate/Test efforts lasted almost two years and were heavily influenced by the process redesign work, best practice research into workflow processes, and by a commitment to make significant changes in the way work was performed. They also relied extensively on physicians to help ensure the processes and the EHR were designed with physicians and providers perspectives in mind. This was accomplished by creating a Physician Advisory Group (PAG), which was reimbursed to meet weekly and perform other tasks related to designing a user-friendly system. The PAG was also committed to helping achieve the benefits that had been promised.

While the DBV and PAG efforts continued, implementation and training teams were formed to work with operations to understand their current processes and design training and workflows that would enable a smooth transition to a paperless world. These teams included process redesign experts to help ensure, through “deep dives” and workflow mapping exercises, that work was transformed and we didn’t just “slam in” an EHR. After the first go-live, the implementation teams were able to take the next hospitals leaders and staff members to the hospital/hospitals which were up. Subsequent hospitals, being able to experience the new world of work in real time and to ask questions of those who had made the journey successfully, was a major enabler and helped each subsequent hospital have an easier transition period.

Process Automation: The five most important processes were documented in the Threshold Application. While many of the process redesigns were primarily driven by technology with Epic, Scanning, Barcoding, several of the process owners recognized that putting in technology solutions would not enable them to transform their processes and achieve the expected benefits to which they had committed and were going to be held

accountable. For example, the process owners who had committed to significant improvements in scheduling recognized that the Epic scheduling system was only an incremental improvement over their existing system. However, having committed to the business case benefits, these leaders worked tirelessly for the next year to redesign their scheduling processes, structure and procedures in order to achieve significant benefits once the software was installed.

Because of the process redesign work and continuing research into best practices, the VP of Medical Records recognized that EPIC scanning would not be an adequate solution. She realized the need to invest in an extensive document management system to achieve the benefits of a paperless environment. In a short time, a vendor was selected and preparations made to implement document management with the first hospital. At go-live the system was unstable and scanning problems caused workflow delays. We immediately implemented follow-up with caregivers around proper scanning techniques and fine-tuned the scanning system, to improve barcode recognition. Through continued analysis we found that we were spending too much time correcting errors. To correct the problem we turned off auto-indexing and HIS committed to index all scanned documents within 30 minutes. The 30-minute goal was achieved almost immediately. A forms committee was also created to standardize and reduce forms. The implementation of scanning at subsequent hospitals was not problematic. See Appendix N for more information on benefits achieved.

Optimization: The CIO, having experienced many technology installs over the years where business case benefits were usually not tracked and the business case not realized, committed in 2008 to put optimization teams into the divisions before, during and after go-live to help operations do the following in priority order:

- Stabilize facility and increase MD adoption
- Achieve eCare business case
- Leverage eCare to achieve additional benefits
- Leverage optimization program to look for non-eCare opportunities (within divisions and system-wide)

These optimization teams, made up of eCare experts and process improvement/redesign professionals, adhered to the following concepts:

- Measure (“what gets measured, gets improved”)
- Budget expected benefits
- Align goals
- Hold process owners, operations and optimization accountable
- Optimization teams support improvement efforts:
 - Project by project
 - Operations must “own” the projects
 - Use appropriate improvement methodology (Lean, Rapid Improvement, Six Sigma)

The teams reported to an Executive Optimization Committee (re-structured EDC after hospitals went live) which had most of the key leaders in the organization attend the monthly meetings. The roles of EOC were to approve prioritization, monitor progress, resolve issues, remove barriers and make eCare related decisions. More active oversight

was provided by the Optimization project management office (PMO). The roles of Optimization PMO were to review potential projects, prioritize projects/resources and share best practice projects/ideas. With the results of eCare exceeding expectations, Optimization is being declared a success and the Optimization team members evolving into a more permanent process improvement/redesign consulting department while a smaller Optimization team will continue to support 2010 and 2011 go-lives.

Sentara Medical Group physician practice EHR benefits include:

1. Automated referral process - We now can track physician-to-physician referrals. This improves patient safety by eliminating overdue referral messages, (meaning no more patients “falling between the cracks”) and increase our “easy to do business with” goal. Providers will soon have the ability to choose between Sentara or Non-Sentara referral providers.
2. Automated central authorizations - The pilot is almost finished. When it is fully implemented, the Referral Management System will automatically conduct the authorizations for MRI and CTs upon the order being entered by the physician.
3. My Action Plan – Primary Care Providers provide this automatically generated health maintenance document to patients at check-in. The plan enables patients to take ownership of the accuracy of their medical information and motivates them (and their provider) to ensure that all necessary preventative care items are addressed.
4. Integration with Optima Health Plan - The Optima Disease Management case managers can now view the record and document their patient interactions for the Primary Care Providers. Also, the HEDIS claims-based data can now be validated by Optima without having the practices manually pulling charts. This has reduced staff time and increased accuracy.
5. Template development – We are piloting standardized templates that achieve two goals. First, they guide the physician to use nationally accepted protocols for managing specific diagnoses (reducing practice variation). Second, they are designed to ensure the physician selects the appropriate billing code for the amount and type of documentation. This will reduce billing resubmissions, denials, and compliance risks.
6. Quality Intelligence – By leveraging the data captured in the EHR, we are now producing disease registries and exception reports for diabetes and heart/stroke quality indicators. This has already led to best practices being identified and implemented in Sentara Medical Group practices. It will also enable us to qualify for NCQA Medical Home recognition for practices, and Diabetes and Heart/Stroke recognition for the physicians.

4.4 User Satisfaction

End user satisfaction with the EHR is an evolving process that requires ongoing measurement and evaluation. Sentara adopted both formal and informal avenues for end users to provide feedback related to EHR use. End user satisfaction encompasses both physician and staff feedback. Sentara utilized both the Epic standard post assessment methodology and a Sentara developed assessment. End users were evaluated by

Epic/Sentara at three intervals (one, four and eight months post go-live). As shown in Appendix E: eCare End User Survey and summarized below, Sentara completed a comprehensive assessment of end user satisfaction following the completion of implementation in one region (Southside Hospitals). Overall, the results of both formal avenues of assessment demonstrated “good” end user satisfaction. The Epic assessment reflected a 7 out of 10 level of satisfaction on a 10-point scale. (One represented “extreme dissatisfaction” and ten represented “extreme satisfaction”) The Sentara assessment demonstrated “good” end user satisfaction with results of four or higher 60% of the time on a 5-point Likert scale.

The formal evaluation process included users from all clinical roles throughout the organization. In addition, physician users were included in both survey processes to assure a comprehensive evaluation of satisfaction. Results of the surveys were shared throughout the organization and feedback was used to prioritize system enhancements and optimization activities. Many workflow and software changes were initiated as a result of the survey processes. Several were significant enough to identify individually. The clinical staff identified that the “effective hand-off tool” could be streamlined to allow for easier communication between caregivers. Through user group activities organization wide, the staff was able to work collaboratively with eCare project staff to revise and enhance this process to effectively meet the needs of “effective communication” and enhance efficiency.

The physician staff identified areas of improvement within ordering and documentation processes. Through user interaction with medical staff and interdisciplinary teams, the physician user group was able to improve order-set content, streamline documentation tools and work collaboratively with the Epic user community to enhance quality of both products. End users from all roles were able to provide valuable insight into improved approaches to education. Through end user feedback, Sentara was able to modify instruction methods to provide a robust and multi-faceted approach to education. Key changes that were made to the educational program included, improved and additional computer based training, interactive learning sessions such as skills day and department based education. Lastly, education for use of the system was enhanced from a generalist approach to be more user role specific. This has resulted in greatly improved end user satisfaction especially within highly specialized clinical areas.

Sentara has established an ongoing mechanism for end user satisfaction assessment. User groups for all major specialty areas including physicians have been established. The key role of these groups is to work collaboratively with eCare project staff to streamline and enhance the quality of software and workflows within the EHR. These user groups meet on a routine basis and have representation from across the organization and user community to assure progression of the efficacy and quality of the EHR solution.

Post Go-Live Survey Summary: In June 2009, we conducted a post Go-live survey of end users at the first four hospitals on the EHR---Norfolk General, Leigh, Bayside and Virginia Beach General. Although the survey included 479 end users of 13 disciplines

from over 36 departments, 60% of the participants were registered nurses. The hospitals had been up on EHR from four to 15 months:

- Q1: Using eCare has made me more efficient on my job?
- Strongly Agree (21%) Agree (39%) Neutral (21%) Disagree (15%) Strongly Disagree (4%)
- Q2: What are your top three documentation challenges?
- Documenting takes too long
 - Patient Care Summary too long
 - Care Plans and Education
 - Knowledge of Flowsheets
- Q3: Does your navigator fit your workflow?
- Strongly Agree (30%) Agree (45%) Neutral (9%) Disagree (10%) Strongly Disagree (6%)
- Q4: What safety issues did implementing eCare rectify?
- Barcode scanning---legibility
 - Access to patient information
- Q5: What safety issues have arisen since eCare?
- Need order entry proficiency
 - Confidentiality
 - Perceived potential for wrong encounter or patient
 - More focus on computer vs. patient
- Q6: What tools or pages do you print to perform patient care?
- Nursing dashboard
 - The My List
 - Unit Census List
- Q7: How often do you choose the wrong encounter?
- 64% ---never to rarely
- Q8: Upon transfer of admission, how do you locate patients?
- Unit census log
- Q9: Upon transfer from the ED, how do you get report?
- Phone call—same process
 - ED Complete Report—need more training
 - Chart Access
- Q10: Are you using the Effective Handoff as designed in eCare?
- Yes (38%), Sometimes (8%), No (54%)
- Q11: If not, what are you using?
- Activities list
 - 5P Paper Form
- Q12: Has pharmacy turnaround time improved?
- Yes (67%), No (33%)
- Q13: What pharmacy issues have been rectified after eCare implementation?
- Quicker med administration (58%)
 - Increased reordering efficiency (18%)
 - Adjusting med administration times (5%)

Q14: What pharmacy issues have arisen after eCare implementation?

- Barcodes do not scan (21%)
- Incorrectly entered orders (17%)

Q15: When you have a question about eCare, where do you go for assistance?

- Another staff member
- Super Users
- Help Desk

4.5 Success in Meeting Other Corporate Objectives

Sentara's strategic plan: With the success of eCare, the building blocks for other major initiatives have been laid. Additional exciting opportunities are being met and/or planned. For example, primary care transformation (to include "medical home concept") redesign efforts were based on the eCare process redesign work. The redesign elements included numerous eCare enabled ideas; (a) expanding the use of MyChart, (b) adding Epic revenue cycle to eliminate the disconnects with the current interfaced solution, (c) standardizing the physician and staff screens and (d) streamlining processes to enable the most appropriate person to perform necessary tasks.

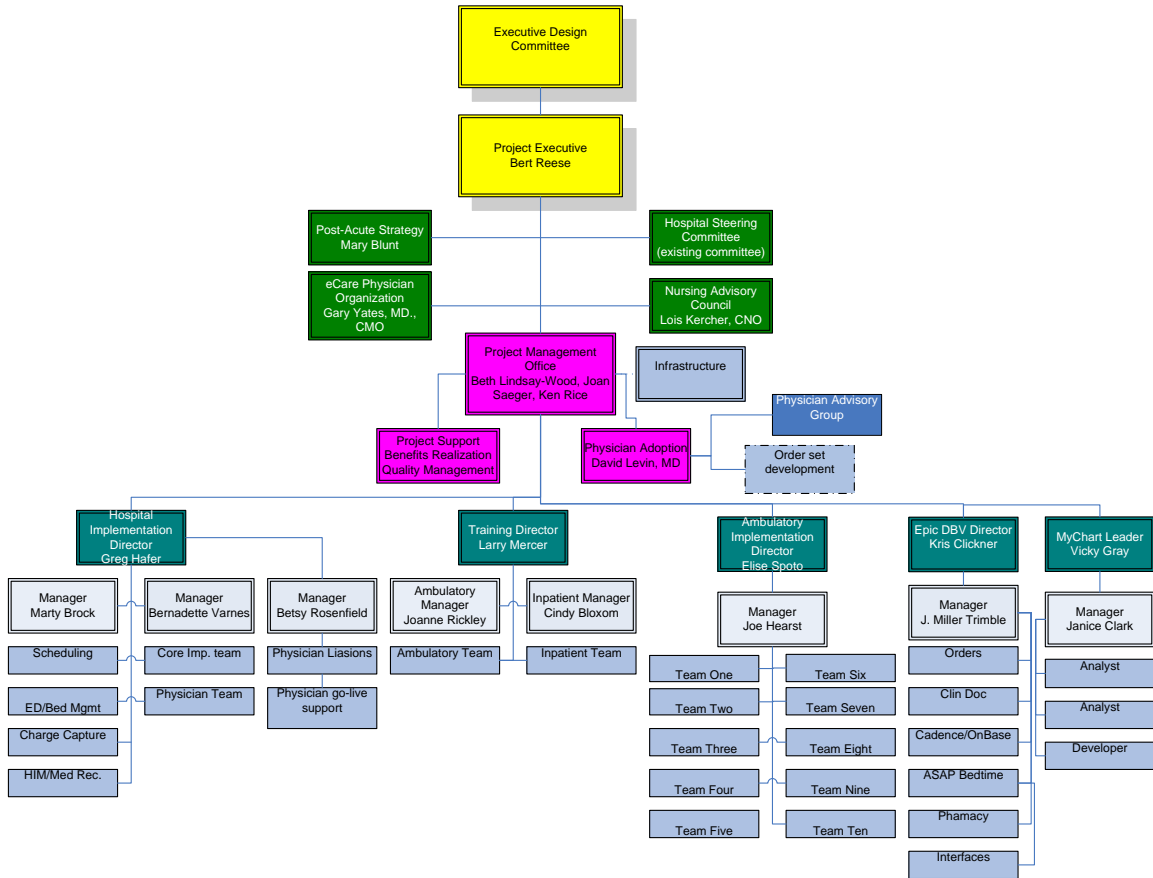
In conclusion, eCare is the cornerstone for Sentara's on-going transformation of care initiatives. Moreover, eCare provides a solid platform to launch advanced strategic programs such as chronic disease management, accountable care organization, advance care planning and primary care transformation. eCare will position Sentara to the forefront of health care reform

What is Next: Sentara's leadership, based on eCare success, has committed \$12 M each year to further technology enhancements to exploit the foundation created by eCare. The focus will be on clinical improvements as well as knowledge management (informatics, using data to improve performance, etc). Transformation of care is another area of focus, and eCare gives us an ability to qualify for meaningful use already and to apply for grants to help us and others search for new ways to provide the highest quality of care for the most reasonable costs. We are conducting a post go-live study by the same consulting firm which did a pre go-live study of nursing units. This in-depth time-and-motion study is designed to measure how work has been transformed on nursing units, to identify any other opportunities for improvements, and to track best practices that can be shared across all units and all staff members.

Other than the challenges noted previously, we have not encountered any significant unanticipated or negative experiences due to the eCare implementation. With six hospitals, more than 100 physician practices and more than 340 physicians live on eCare, Sentara's leadership has declared success of the \$237 M project. While work continues, we can shift focus to exploit the foundation that Epic EHR, Onbase Scanning and Medication barcoding has provided. Having realized more than \$37.3 M annual business case and additional ROI benefits and dramatic improvements in quality, safety and throughput measures, we are poised to pursue more aggressive transformation activities.

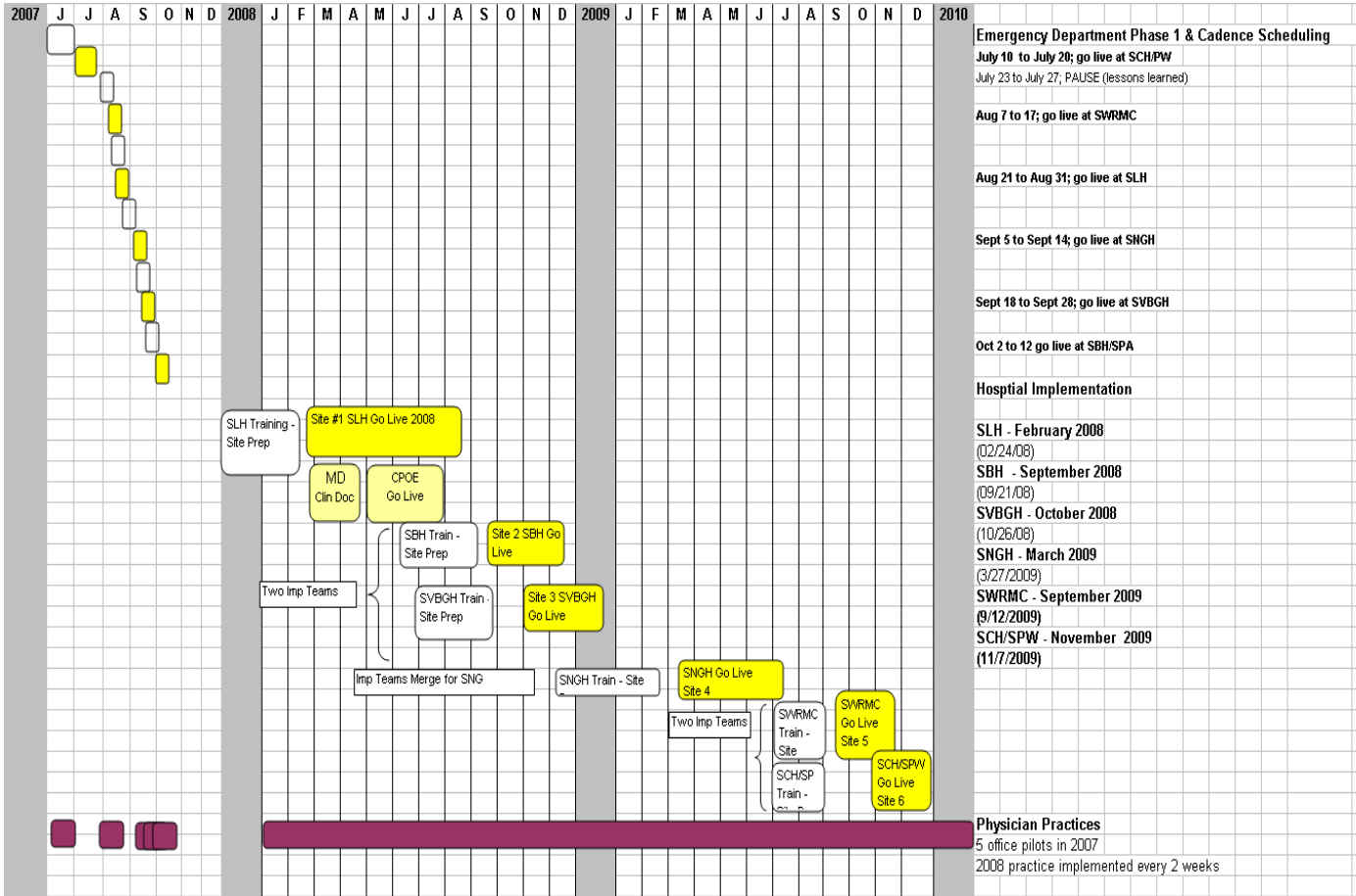
Appendix A. eCare Project Management Office Organization Chart

2006-2009

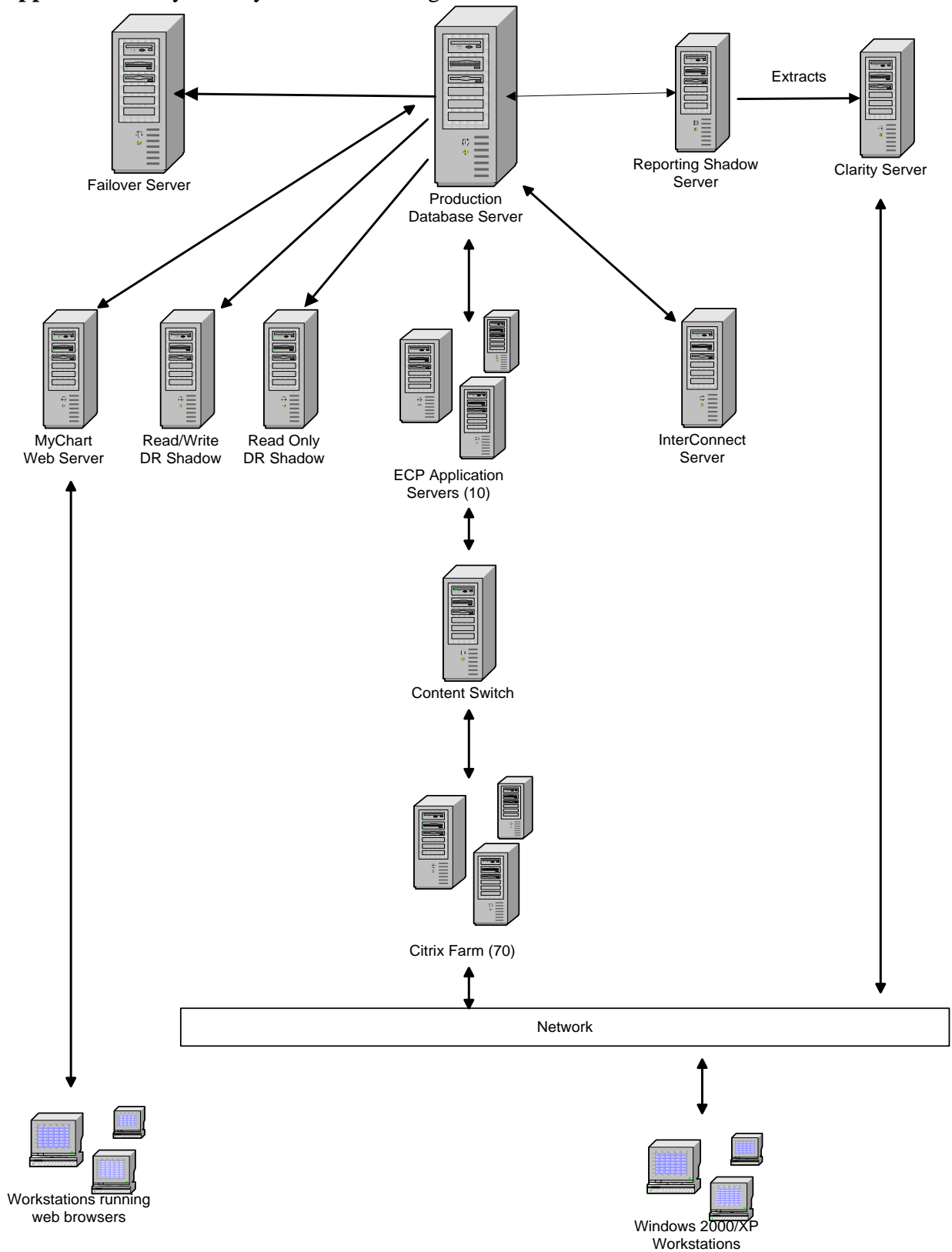


Core Hospital Implementation team includes; Inpatient core processes, Cardiac, Pharmacy, Critical Care, Inpatient Ancillaries, ED Orders/Documentation, Inpatient Support Services, O/P Therapies/Procedures

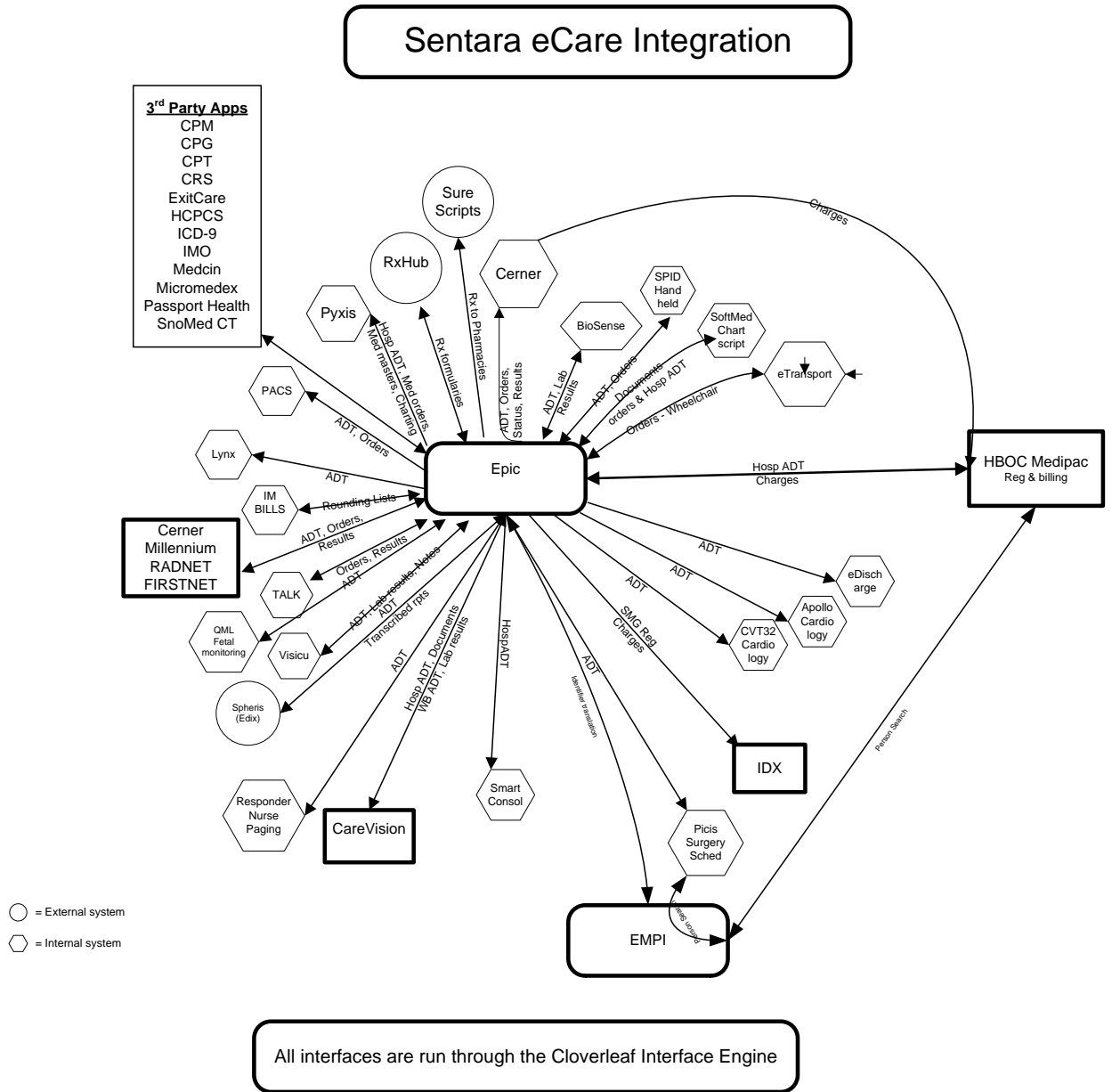
Appendix B. eCare Plan B Implementation Schedule 2007 – 2010



Appendix C. Physical layer network configuration for eCare Health Network



Appendix D. Sentara eCare Integration



Appendix E. eCare User Survey

DEMOGRAPHICS: NAME: _____ HOSP/Unit _____

Position: RN LPN PT OT ST RRT RT OTHER _____

Number of years in position: _____ Length of time using eCare: _____

Efficiency	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1. Using eCare has made me more efficient in my job					
How so? (Please be specific)					
Documentation					
2. What are your top three documentation challenges?	Issue/Comments- including in specific detail how you get around it:				
a. Do you think this is just you? (circle response) YES NO Do you think the entire dept. does it this way? YES NO Or do you think 1/2, 3/4 of the dept is affected? (circle choice)					
b. Do you think this is just you? (circle response) YES NO Do you think the entire dept. does it this way? YES NO Or do you think 1/2, 3/4 of the dept is affected? (circle choice)					
c. Do you think this is just you? (circle response) YES NO Do you think the entire dept. does it this way? YES NO Or do you think 1/2, 3/4 of the dept is affected? (circle choice)					
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Navigators					
3 Does your navigator fit your workflow?					
a. If not , how would you change it?					
Safety					
4. What safety issues did implementing eCare rectify? (Please be specific)					
a. What safety issues have arisen since implementing eCare?					
Clinical Encounters					
5. <i>If applicable:</i> How often do you choose the wrong encounter?	Frequently		Sometimes		Rarely
a. What do you do once you realize you've done that? How is it "fixed"?					
6. Upon Transfer or Admission, how do you locate the patient?					
I use the following:					
a. Unit Census Log					
b. Clinical Encounter lookup					
c. OR/IR Today Button					
d. Transferring Unit's Census					
e. Other: (List): _____					
Workflow					
7. What flow or process has changed from how you were trained to use the system?					
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
8. What tools or pages do you print to perform patient care?	Frequently		Sometimes		Rarely
a. Nursing (or NCP) Dashboard					
b. My List – Patient List					
c. Unit Census List					
d. Other:					
e. Other:					
f. Other:					
g. Other:					
Comments: (please add your observations)					

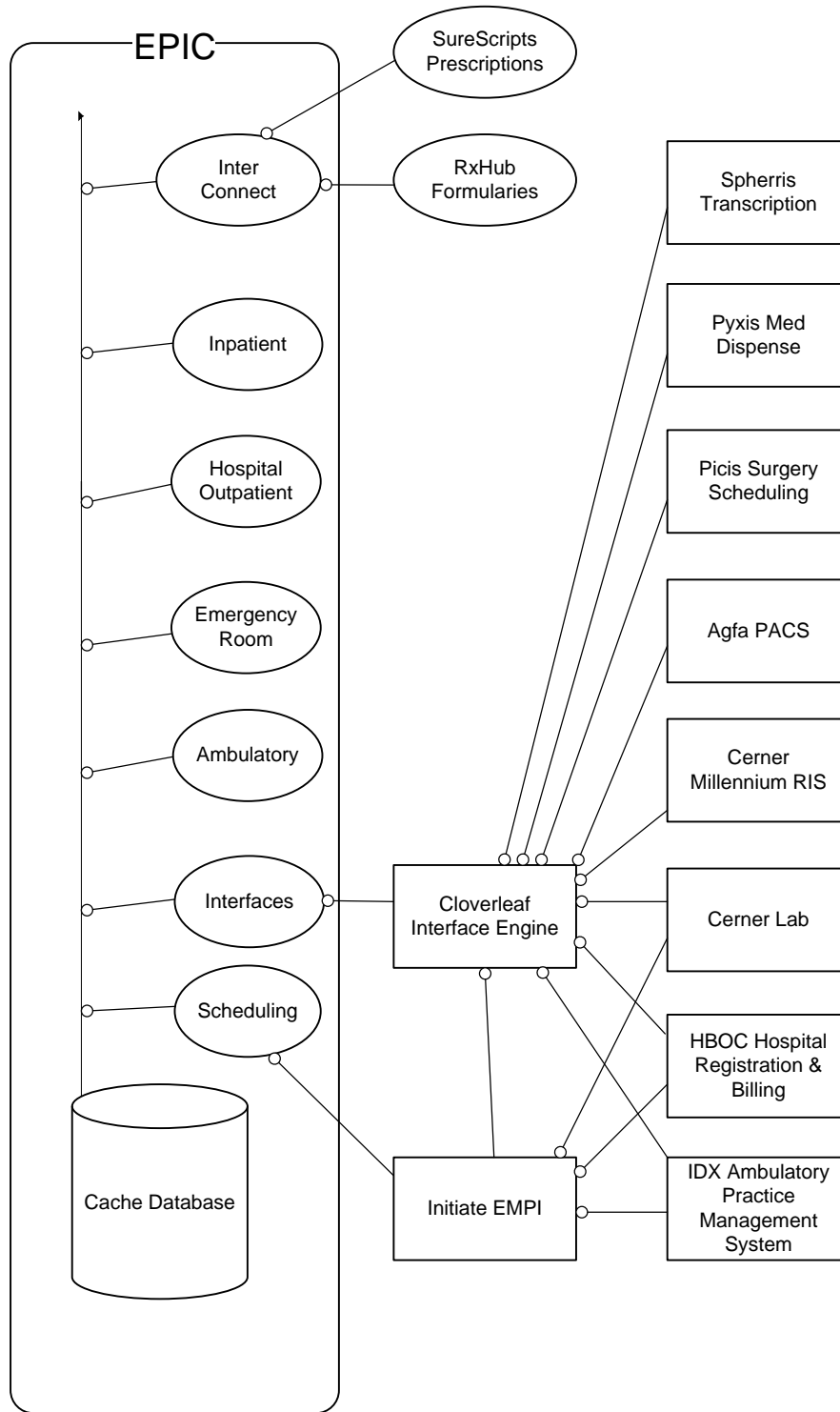
Effective Handoff	YES			
9. Are you using the Effective Handoff as designed in eCare?			Sometimes	NO
a. If not: what ARE you using?				
a. I use the Sections from the Activities List				
b. I use the 5P Paper form				
c. I use the system but randomly access various sections depending on the pt or the day				
10. For IP Units: How do you receive an Effective Handoff before a patient arrives from the ED to your unit?				
a. I receive a telephone report from the ED				
b. I review the ED Complete Report				
c. Both of the above				
d. Neither, I access the ED census and review the chart				
Pharmacy Services				
11. What pharmacy issues have been rectified after eCare implementation?				
a. What pharmacy issues have arisen after implementing eCare?			YES	
12. Has pharmacy turnaround time improved?	Always			NO
Comments:				
Support			Sometimes	Never
13. When you have a question about eCare, where do you go for assistance?				
a. The unit Resource Book				
b. The online Resource Book (Wavenet)				
c. One of our unit Super Users				
d. Call the Help Desk				
e. Another staff member/peer (not a SU)				
f. Other:	Strongly Agree			
Training/Education		Agree	Neutral	Disagree
				Strongly Disagree
14. We want to know how helpful each of these teaching/training methods was in helping you in learn about and use eCare?				
a. Formal (1 2 3 day) Training				
b. Unit Based or Inservice Training				
c. CBT - Computer Based Training				
d. Skills Day (if applicable)				
e. Lunch and Learns				
f. Using the system -- after implementation				
g. Other:				
Devices			YES	
15. Is a computer readily available for you to use to chart?	YES		Most of the Time	NO
a. Are you able to do real time charting?			Most of the Time	NO
b. What would you change? (location, additional devices, type, etc)				
Additional Comments:				

Appendix F: Applications Implemented Table

Application (Imp. Date)	Functionality	SN 3/09	SL 2/08	SV 10/08	SB 9/08	SC 11/09	SW 9/09	SMG 2007-2009
Cadence Ambulatory	Full scheduling capabilities for ambulatory clinics.	I	I	I	I	I	I	I
Cadence Hospital	Full scheduling capabilities for inpatient.	I	I	I	I	I	I	
Clarity	Ability to access reports developed by the project's Clarity Reporting Team.	I	I	I	I	I	I	
EpicCare Ambulatory	Clinical documentation tools, including notes and templates, vital signs entry, and all form of documentation.	I	I	I	I	I	I	I
ASAP	Status board, documentation tools and order sets.	I	I	I	I	I	I	
Barcoding		I	I	I	I	I	I	
Bedtime		I	I	I	I	I	I	
EpicCare Inpatient	CPOE; nursing documentation and workflow support; Medication Administration Record (MAR); interdisciplinary clinical notes; patient education; and charge on administration.	I	I	I	I	I	I	
EpicCare Rx	All pharmacy functions, including pharmacy work list, Pyxis integration, medication charging, allergy and drug alerting, and medication database.	I	I	I	I	I	I	
Beacon	Oncology application including treatment plans based on standard protocols, treatment decisions and personalized plans for both adults and pediatric patients.	P	P	P	P	P	P	
HIM	Chart and file management and tracking, release of information, coding and deficiency racking.	I	I	I	I	I	I	
MyChart	Patient portal allowing patients online access to portions of their medical record, such as labs, medications and appointment scheduling.	I	I	I	I	I	I	I

In Process	P
Implemented	I

Appendix G: Representative Information Flow Graphic

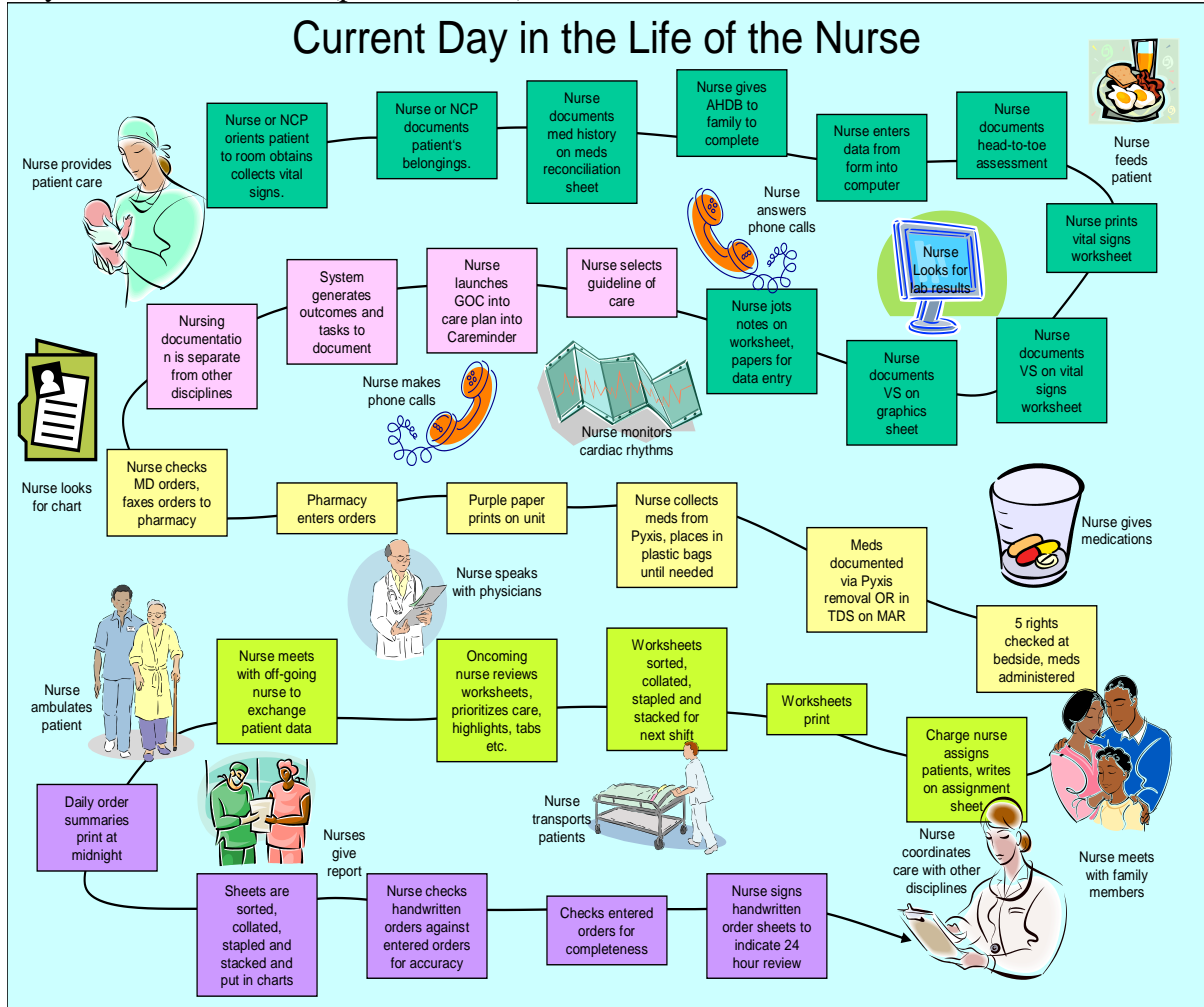


Appendix H: Clinical Decision Support Table

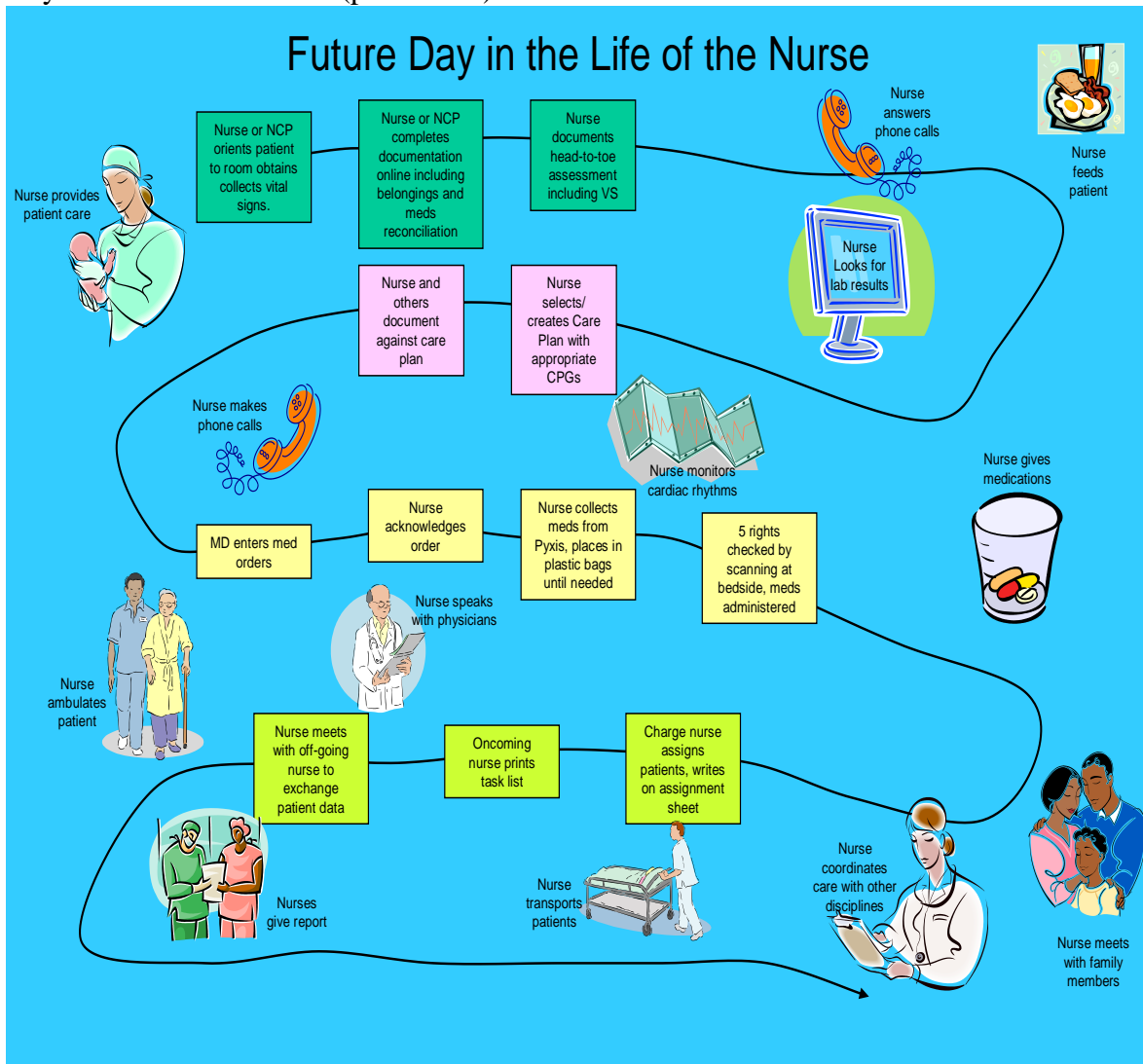
Location	Clinical Decision Support	Physicians	Nursing	Pharmacy
Inpatient	Dose Range Checking (Y/N)	Y	Y	Y
	Drug-Drug (Y/N)	Y	Y	Y
	Drug-Allergy (Y/N)	Y	Y	Y
	Drug-Food (Y/N)	N	N	N
	Drug-Laboratory (Y/N)	Y	Y	Y
	Links to Resources (Y/N)	Y	Y	Y
	Regulatory Compliance (Y/N)	Y	Y	Y
Outpatient	Dose Range Checking (Y/N)	Y	Y	Y
	Drug-Drug (Y/N)	Y	Y	Y
	Drug-Allergy (Y/N)	Y	Y	Y
	Drug-Food (Y/N)	N	N	Y
	Drug-Laboratory (Y/N)	Y	Y	N
	Links to Resources (Y/N)	Y	Y	Y
	Regulatory Compliance (Y/N)	Y	Y	Y
ED	Dose Range Checking (Y/N)	Y	Y	Y
	Drug-Drug (Y/N)	Y	Y	Y
	Drug-Allergy (Y/N)	Y	Y	Y
	Drug-Food (Y/N)	Y	Y	Y
	Drug-Laboratory (Y/N)	Y	Y	Y
	Links to Resources (Y/N)	Y	Y	Y
	Regulatory Compliance (Y/N)	Y	Y	Y
SMG	Dose Range Checking (Y/N)	Y	Y	Y
	Drug-Drug (Y/N)	Y	Y	Y
	Drug-Allergy (Y/N)	Y	Y	Y
	Drug-Food (Y/N)	N	N	N
	Drug-Laboratory (Y/N)	Y	Y	Y
	Links to Resources (Y/N)	Y	Y	Y
	Regulatory Compliance (Y/N)	Y	Y	Y

Appendix I. Workflow

Day in the Life of Nurse (prior to eCare)



Day in the Life of a Nurse (post eCare)



Appendix J. Key Performance Indicators

“EHR use for real-time Key Performance Indicators (KPI) measurement and dissemination (clinical and financial)”

In December 2008, Sentara Healthcare launched our Executive KPI Dashboard to provide near real-time data to our leadership team on key performance metrics ranging from Financial, Census, Operational Effectiveness, and Clinical Effectiveness indicators. The KPI Dashboards provides not only red/yellow/green performance indicators, but also allows managers to look at the trends in those indicators over time.

Leveraging daily feeds from our EPIC EHR, Sentara is tracking key performance indicators at the enterprise, hospital, and department level for targeted clinical areas which include: hyper- and hypoglycemic rates, average Foley line duration, and percentage of heart failure patients weighed daily. In addition, focused patient safety indicators area also tracked daily for CPOM rates (down to the physician level), medication and patient scan compliance rates. We are also able to track specific health events over time, by pulling in lab results, we were able to track the fluctuation in flu rates and respiratory infection rates over time, which better prepared us for respond to the community by having appropriate level of staffing support and needed supplies by geographic area.

From an operational effectiveness focus, our near real-time data feeds enable us to display patient census and occupancy rates three times a day: by facility, by unit and type of service, and by financial class. We provide that information with other performance statistics from our Emergency Department, which include tracking boarder hours and ED turn-around times for minor emergency care, arrival to triage, arrival to admission, and arrival to discharge by level of care. The leadership team is also getting updates on the dashboard every 15 minutes of the average patient wait time in the ED, we are now able to use this information to provide escalation alerts to the leadership team when defined thresholds are exceeded.

Finally, key financial indicators and volume statistics are also included on the KPI dashboard. Managers have the ability to monitor daily, month to date, and year to date, statistics on volume and associated revenue by defined categories. Sentara provided capabilities for trending over time dollars, units of service, patient days, margin analysis and revenue by payor. Monthly benchmark statistics are also available to compared expected values at a facility level.

The Executive KPI dashboard is web-based and is automatically launched upon access to Sentara’s network, it is also available via secure login from outside of Sentara’s network so the manager and/or executive has access to key performance indicators wherever there is internet connectivity.

Appendix K. Technical Downtime, Business Continuity, and Disaster Recovery

The Sentara eCare system schedules downtime on the 2nd and 4th Sunday of each month at 4:00 AM, as necessary. The typical downtime for code updates is 10-15 minutes. A more substantial change such as a hardware upgrade or a firmware upgrade usually takes from 1-2 hours. During this time, the eCare users are directed to a Read-Only shadow environment.

Sentara has also employed a Business Continuity Access (BCA) model, then sends predefined patient information to downtime workstations and web servers. In the event of a complete system and network outage, these workstations can be used to print patient reports. The web servers can be used in a WAN outage, if the LAN at the facility is operational.

Our Disaster Recover (DR) strategy has multiple levels. The first level is immense redundancy in the existing hardware. Sentara also employs a separate Read/Write shadow that can be up and functional in approximately 10 minutes (RTO). The acceptable amount of data loss in this situation (RPO) is a little less than 10 seconds. Currently the Read/Write is housed in the same Data Center as the production servers. This is due to change with a hardware refresh in 2011. An addition layer of DR is provided with a contract with SunGuard, where Sentara leases identical hardware as our production environment and sends system backups to this site.

Appendix L. Benefits Tracking

Prior to the first hospital going live, the Process Improvement Department, who were responsible for tracking and reporting each hospital's performance against each expected benefit, created an eCare Benefits Team. This team consisted of the Process Improvement Director, each of the 18 process owners, a Finance VP, and an Internal Audit representative. This team met several times to work out the details for how each specific benefit was going to be tracked, down to the specific metrics, cost centers, accounts, formulas and adjustments to make the baseline and post go-live measures as close as possible to an "apples to apples" comparison. The Process Improvement Department created a data dictionary for each of the business case benefits tracked so that there was a documented accounting of the detailed measurement plan. Here is an example of one of the benefits tracked as described in the data dictionary:

Streamline physician record completion

- Measures: Medical Record Staffing
- Frequency: Quarterly
- Details: Departments 8250-8269 (HIM), Medical Records Staff occupation codes
- Source: Payroll Download
- Baseline: 2006 Med Rec Labor \$ adjusted for current year \$ + HR/Benefit costs
- Benefit: 2006 Medical Record Labor \$ - Current Medical Record Labor \$
 - Includes HR/ Benefit Costs with Labor Costs
 - HR/ Benefit Costs = 28% of Salary Costs

The eCare Benefits Team met twice a year the first year, then annually thereafter to confirm the expected benefits and the measurement plan with each of the process owners. There were several challenges to the way the measures were calculated, and where logic dictated a modification, the decision was to do so. If the impact was significant, recommendations were presented to the Executive Design Committee for decision.

Appendix M. Beacon (medical oncology functionality)

Early on, we decided to adopt new functionality, which focused on the management of medical oncology protocols. That functionality was implemented in the first three hospital sites. Physicians, nurses and pharmacists at these initial sites felt significant changes were necessary to improve patient safety and efficiency; the executive team approved the decision to stop oncology implementation until improved functionality is available. Plans are in place to readopt and implement the improved functionality in 2011.

Appendix N. Benefits Achieved.

Medication administration times have decreased dramatically, principally due to CPOM, but also due to medications barcoding and document management (scanning).

A pre-Epic time and motion study found bottlenecks in the written order delivery process as well as delays due to illegibility of orders or clarifying questions arising during pharmacist order entry. Prior to CPOM implementation, physicians would write orders that, depending on their urgency, collected in an in-basket waiting to be faxed to pharmacy. Once pharmacy received the order and began order entry they received alerts on dosage, drug-drug interaction or allergies that may have been unknown to the physician at the time the order was written. The order entry process would then be delayed while the physician was contacted to resolve these patient care questions. Post CPOM implementation, orders are entered by physicians, eliminating the order delivery bottleneck, and during that process physicians immediately address some of the alerts that were previously seen by pharmacy.

Pharmacist order verification has replaced pharmacist order entry. The verification process is streamlined due to the efficient organization of the EMR and the ability of the pharmacists to quickly view the entirety of a patient's chart. In addition, because of the structure and implementation of the EMR, pharmacists can easily share their work electronically by sharing their work queues.

For the few med orders that are not entered by physicians, the scanning process implemented at go live has also contributed to the decrease in order entry turnaround time. Pre-Epic, pharmacy received faxed med orders that were difficult to keep queued properly. Post-Epic, scanned orders are queued electronically according to first in, first out and order urgency. Each pharmacy workstation consists of dual monitors with the order appearing on one and the order entry screen on the other.

Prior to go-live, nursing was required to check the medications cabinet or in-basket for newly entered med orders. Post go-live, nursing is notified electronically as soon as an order is entered for any of their patients. In addition, some of the double checks previously completed with another nurse at the medications cabinet have been replaced with the automated double check of medication barcoding scanning. Another contributing factor to the decrease in med administration turnaround times is the med location flag on the eMAR. This flag tells nursing where a med is stocked at any given time and helps prevent nursing from spending valuable time trying to track down a med.

The order entry process has decreased from an average of 52 minutes pre-Epic to 5 minutes post-Epic. The administration of Sentara defined NOW orders decreased from an average of 132 minutes pre go-live to 38 minutes post go-live. These huge timesavings in process measures have had exceptional impact on several outcome measures, such as reducing length of stay and speeding up the overall process of care.