14

Avera eCARE®, a Comprehensive Telemedicine Program for the Rural North Central Region of the United States

Edward T. Zawada Jr. M.D., M.A.C.P., David Kapaska D.O.,
Pat Herr C.C.R.N. and Michael Heisler M.D.
Avera eICU® Care
911 East 21st Street, Suite 405, Sioux Falls, SD 57105,
USA

1. Introduction

1.1 Early history of telemedicine in the North Central United States

South Dakota is the 17th largest state in America with an area of 77,000 square miles. It has a total population of 812,000 which ranks 46th of the 50 states. The population density of the state is also 46th of 50 states. The state can only be represented by one member in the House of Representatives, while it has two senators. Sioux Falls is the largest city with a population of 160,000 and is located near the southeast corner which borders Iowa, Nebraska, and Minnesota in a tri-state strategic location, often described as providing services to an estimated 1 million people. North Dakota and Wyoming form the north and west borders nearly 200 miles and 400 miles away respectively.

The Avera Health system is a Catholic non-profit system of hospitals, clinics, and long term care facilities which supports the population not only in South Dakota but to the surrounding states of this North Central region of the Midwest. It began with two separate religious groups. The Benedictine sisters in 1897 began to provide health care in the original capital of the Dakota Territories, Yankton, South Dakota. The Presentation sisters began their health ministry far to the north and west during diphtheria and typhoid epidemics in Aberdeen South Dakota in 1901. Nearly 100 years later in 1999 the two ministries joined their numerous sites of service to become Avera Health. This system now supports integrated facilities and non-integrated independent partners. Included in the growing Avera network are one tertiary care, university affiliated, health center in Sioux Falls, a series of smaller community hospitals, critical access hospitals (rural hospitals smaller than 25 beds and more than 35 miles from another hospital), many isolated clinics, several nursing facilities, and many free standing clinics. Figure 1 shows a 4-state area in the upper Midwest consisting of Minnesota to the East, North Dakota to the North, and Iowa to the Southeast. Shown are many of the approximately 228 sites in the system or in partnership. These entities are usually separated from each other by 50-100 miles. Many do not have a physician residing in those towns but are supplied by outreach from the next largest location of health professionals. Known challenges to rural care in this region include workforce shortages due to difficulty in recruiting all types of caregivers to an area with

geographic isolation and substantial inclement wintry weather. Many communities are experiencing diminishing economic growth. The facilities are experiencing lower healthcare margins, but also an increased attention to sustain high quality of services.

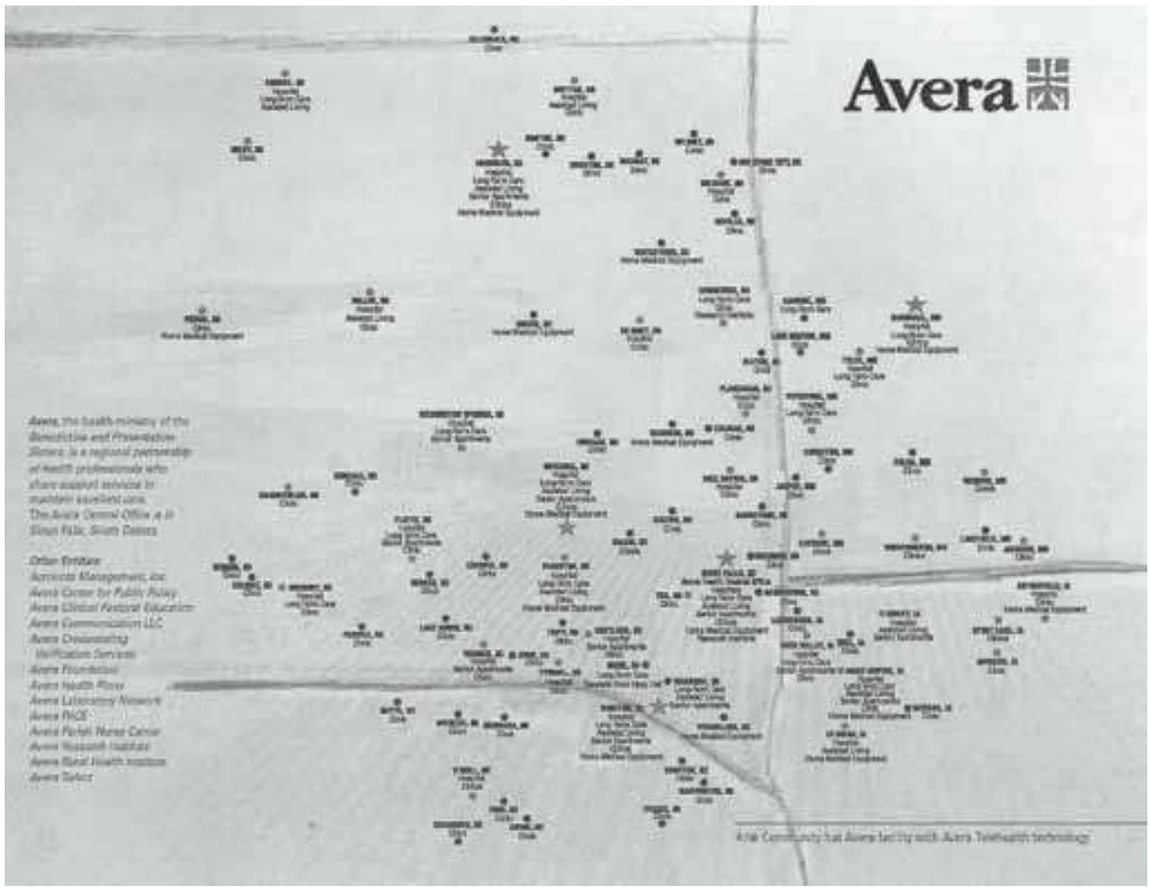


Fig. 1.

In 1993 the Avera Health System realized the importance of using telemedicine to add more services to this wide geography and launched its first telehealth services. Isolated projects continued to be developed, and now a comprehensive telemedicine program called eCare Services is provided to the region. The financing of the program has also grown in part by the willingness of the multiple isolated locations to bear the costs, but later due to the acquisition of grant support.

1.2 Telemedicine provision specialty and subspecialty consultations

Telemedicine consultation to the region was the earliest project. It began by installing televideo connectivity from a location usually in the main hospital to a clinic room at the distant site. The model now has the video equipment in the specialist's office suite. At the distant site a nurse attends the patient and can use a variety of electronic tools to transmit video and audio information back to the specialist. The audio and video is two-way, providing an interactive consultation aided by exam cameras, electronic stethoscopes, and video otoscopes. Figure 2 gives a brief example of this program called eConsult.

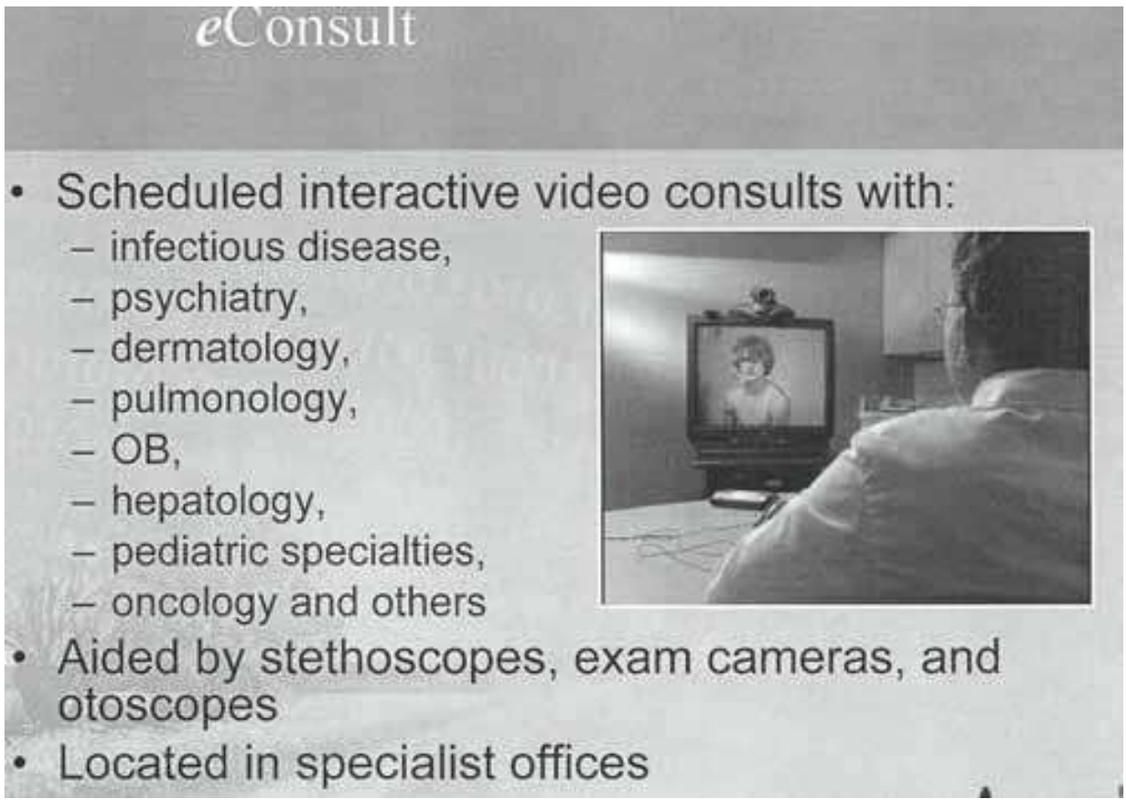


Fig. 2.

At first specialists in short supply were requested, such as psychiatrists and obstetricians as the region primarily delivered care by Family Medicine Physicians. Later, demand for subspecialties increased, including pediatric subspecialties and internal medicine subspecialties such as pulmonology and infectious disease. The visual nature of dermatology has made it easy for family physicians or mid-level providers to seek clarification of several possible diagnoses by ease of close-up video augmentation. The demand for eConsult services has continued to grow. As new subspecialties arrive at the tertiary care facility, their services are in great demand since the outreach areas have always had to send their patients long-distances out of the region. Figure 3 gives an idea of the growth of eConsult services since inception.

1.3 A tele-intensivist program, eICU®

The tele-intensivist program was the next large project to be launched. It now has expanded the quickest into the most number of sites connected to the tertiary care health center. In 2004 the medical leadership of Avera was impressed by a vendor (VISICU™, now Phillips) offering a product called e-Care Manager™ which could provide 24-hour tele-video supervision of seriously ill patients. The product included a high quality camera with zoom characteristics and a two-way microphone. Computer software was installed at the hub or Core site, located at the tertiary facility, that screened physiologic and laboratory data and medication lists streaming from each patient's database for abnormal trends. Once an abnormal trend was identified as outside pre-set limits based on admitting diagnoses, an alert was sounded at the Core for possible intervention. A steering committee was

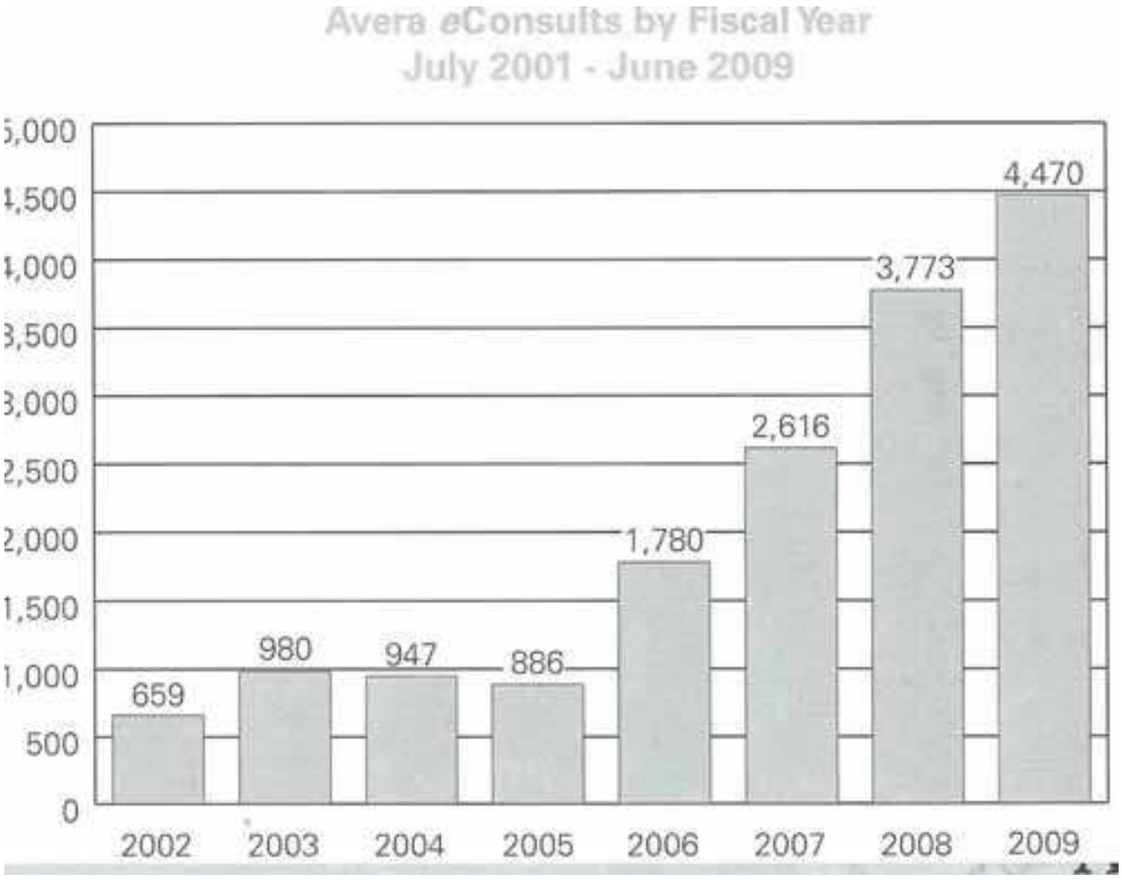


Fig. 3.

developed to implement what was called Avera eICU® CARE™. This committee spent approximately 9 months recruiting physicians and nurses to staff the control center which became identified as the "eICU®," arrange hospital privileges for the staff to practice in each participating hospital, obtain approval at each site for protocols for intervention, and supervise the schedule of the electronic set-up process in each institution. On September 21, 2004 the first site connected to the eICU® was launched. Over the next few weeks a total of four regional hospitals were having 24-hour supervision of their seriously ill patients. As of October 1, 2010 our eICU® is now responsible for the oversight of 25 sites and 102 patients. Figure 4 illustrates our core-station now simply called Avera eICU®.

In the control center, there are critical care nurses able to respond to bedside nurses at the remote sites to assist with more advanced monitoring than might ordinarily be provided routinely at such rural sites. Assistance is often provided for titration of medication drip infusions, preparations for special tests, and advice as to when a physician's input is needed concerning a particular patient problem. The core nurse also compiles a task list for the core physician that includes assuring for each patient that best practice strategies such as deep vein thrombosis prevention and gastrointestinal ulcer prophylaxis are in place. Nursing services are provided by two 12-hour shifts: 7 a.m. to 7 p.m. and 7 p.m. to 7 a.m. The eICU® nurses have assumed the greatest role in compiling and managing data, including attending physician and consulting team notes in order to create the initial admission note and daily

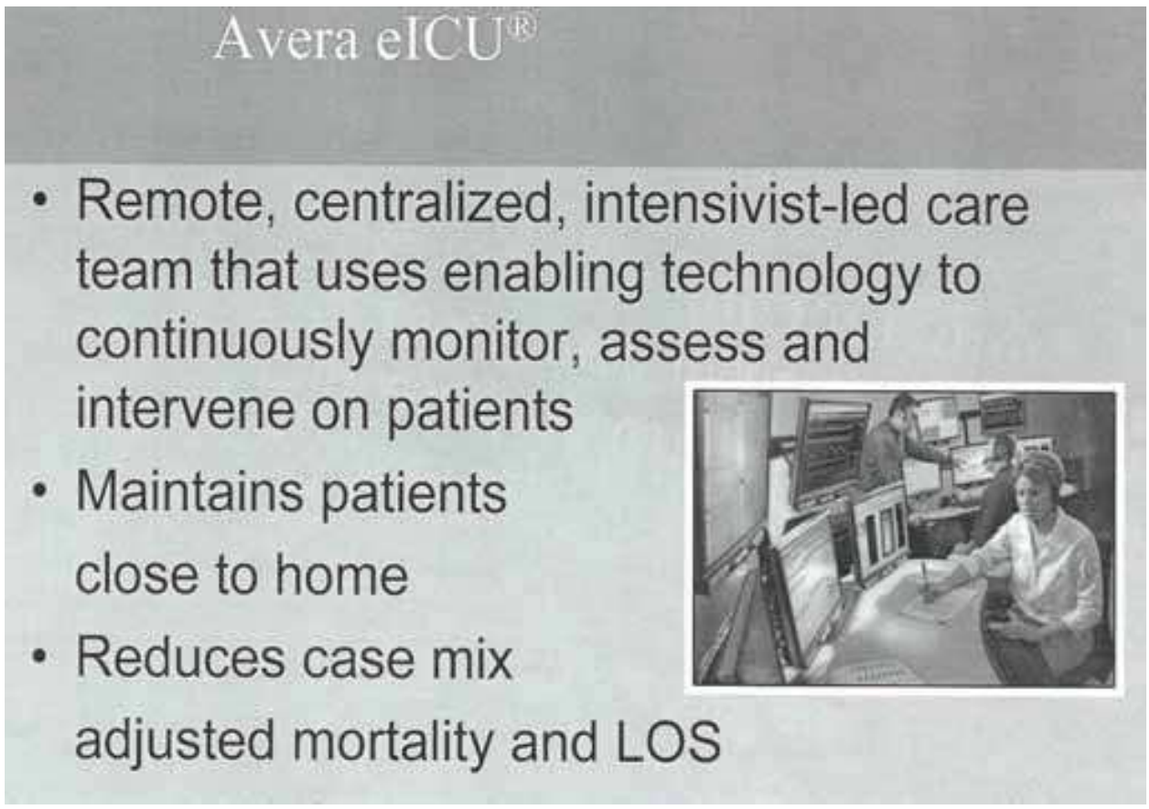


Fig. 4.

comprehensive progress notes. Accurate data is also necessary to obtain risk adjusted mortality and length of stay predictions. The eICU® nurses also assist in transfer of patients from remote sites to the tertiary care facility when it is requested by the local attending physician or determined by collaboration between the eICU® physician and the primary local attending team.

Figure 5 is a close up view of the five screens monitored by staff. At the top left is a screen on which are displayed the alerts detected by the software monitoring the bedside vital signs. The lower left screen is the audio-visual interaction with each patient room. The lower center screen contains the composite electronic database of all patients monitored at a given time. It includes admission and follow-up e-notes; up-to-date medication lists electronically linked from the patient's medication record at the bedside; electronic order writing capability; and laboratory flow sheets. The top right screen reproduces in real time any of the specific patient bedside monitors to create telemetry for that patient. In other words instead of only delegating the telemetry to the computer software, the clinician can also note changing vital signs, worsening ventricular rates in patients with arrhythmias, and deteriorating oxygen saturations in recently extubated patients to give a few examples. Finally, the lower right screen allows entry into each hospital's electronic medical record to be able to display additional data kept separately in those databases including imaging data.

A critical care physician is available for all but the usual morning rounding time for most physicians. This allows the critical care physician to be a resource when the primary physician is not directly available to the bedside. The primary bedside attending physician chooses in advance from several categories of requested communication frequencies from

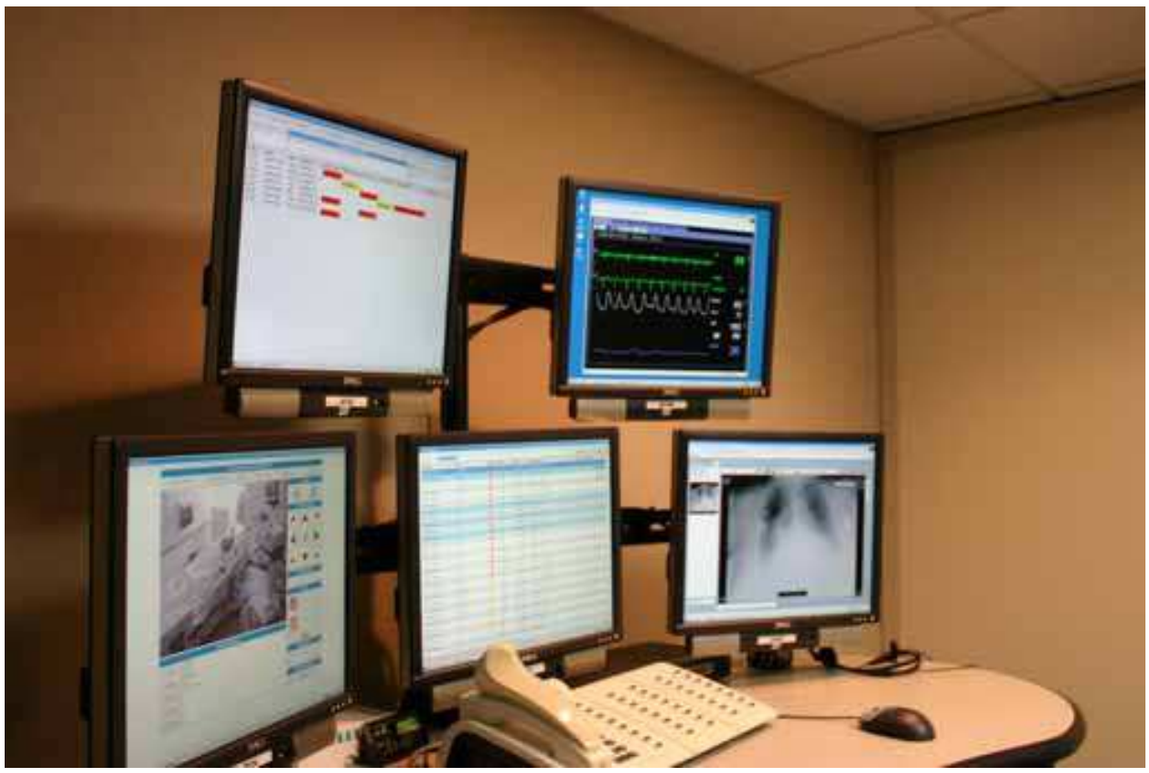


Fig. 5.

the eICU® physician. Category I means that the bedside physician requests emergency interventions only and best practice initiation before being contacted. Category II physicians want the eICU® to adjust the care plan but to call them or their local covering partner regarding the need to initiate any new therapies. Those who request Category III status give full authority to the eICU® staff to manage their patients in their absence. They ideally check out their patient at the end of the day and check in for an update of patient status before their morning rounds. They will be notified of major or significant changes in their patient's conditions by the tele-intensivist.

The eICU® physician performs electronic rounds upon arrival for their shift. They use the software to stratify the patients in three categories of severity with a color-coded icon attached to the electronic database. Red patients are new admissions or unstable patients and generally require some evaluation by the physician hourly. Yellow coding suggests that the patient has reached a point of stability to where evaluation by the e-Care physician is suggested approximately every two-hours. Finally, a green icon suggests that the patient has reached a phase in which the care plan is being completed and only minor adjustments in care are expected for the day. However, ongoing monitoring does occasionally find a crisis in these patients which requires new major diagnostic or therapeutic interventions. Such activity is likely to result in change back to a "yellow" or "red" status.

The eICU® team is constantly monitoring all the remote patients and is assisted by the software which generates abnormal trending alerts. These are often not apparent to the bedside team because they are only seeing real-time vital signs, laboratory tests, and pharmacy lists. The alerts compare current vital signs with previous values and identify the abnormal trends. The software also alerts when pharmaceutical interactions are possible when a new

drug is ordered. The alerts suggest change in dosing for changing renal and hepatic status as the software monitors renal function by estimated glomerular filtration and monitors hepatic function by liver function test results. The eICU® staff is notified immediately when laboratory results are reported as they interface to the core computer. The laboratory tests are also color-coded: green if normal, yellow if slightly out of range, and red if markedly out of range.

Finally, the bedside team can request immediate televideo connection by the eICU® into a given patient room by pressing a red "e-Alert" button located near the "code" button. This can summon the eICU® team to assist with initial management of a code blue, to assist with urgent hemodynamic or oxygenation issues, or also for updates on status. Such updates might include reporting when patients are transferring out of the room or returning from tests, have recently been intubated or extubated, or even when family is requesting additional input such as an update from the eICU® physician.

Each day there is a to and fro set of interactions between the bedside team and the eICU® team. For example, requests are made by the bedside nurses to the eICU® nurses for assistance with unexplainable monitoring data that appears to be artifactual. They may request the eICU® nurse assistance to confirm nursing diagnoses. There are requests by the bedside nurses to the eICU® physicians for routine orders such as pain or sedation needs. The bedside nurses may request the eICU® physician to review x-rays for evidence of proper position of endotracheal tubes, central lines, and oro- or nasogastric tubes before their use. The eICU® nurses and physicians may call the bedside team to clarify whether an abnormal change in a vital sign has come to their attention, whether there is a bedside activity such as a bath or suctioning which might explain the abnormal trend, and to jointly determine a solution to the alerted problem. The eICU® physician writes orders electronically in the software database which is printed in the given ICU and then is included on the patient chart. The eICU® physician will give a detailed explanation of the rationale behind orders in a printed note that is placed on the patient chart. These notes serve as a reference for the bedside physician for events than occurred in their absence.

1.4 ePharmacy

Once the Avera eICU® CARE was up and running, it was noted that frequent requests would be made by the local attending physician or the local hospital pharmacist for information on dose adjustments or drug formulations. The eICU® team had easy access to critical care pharmacy interns, fellows and staff for detailed explanations and the rationale behind their suggestions. As a consequence of these frequent requests, the Avera Health System eventually launched a tele-pharmacy program in 2009 which is located in the eICU® core facility as well. This allows for independent contracts by local hospitals for remote medication order review and order entry. Location inside the eICU® also allows for interactions between the eICU® core nurse and physician with the pharmacists for clinical adjustments in doses based on ideal weight, concomitant medications, and reduced hepatic and renal function. Smaller rural hospitals may not even have pharmacists on site for much time each day. The ePharmacist can meet the needs of the nurses and physicians at those sites. ePharmacy services are available 24 hrs a day. They are physically located in the eICU® from 7 a.m. until 9 p.m. and work out of the main hospital Pharmacy the remainder of the time. The goal is to become a 24/ 7 service in the eICU® CARE as soon as staffing allows. The ePharmacist uses the eICU® software to write consulting notes to explain the formulations of adjustments and to offer suggested times for drug levels to be sent to the laboratory. Such pharmacokinetic advice is well-received. Figure 6 illustrates the ePharmacy program.

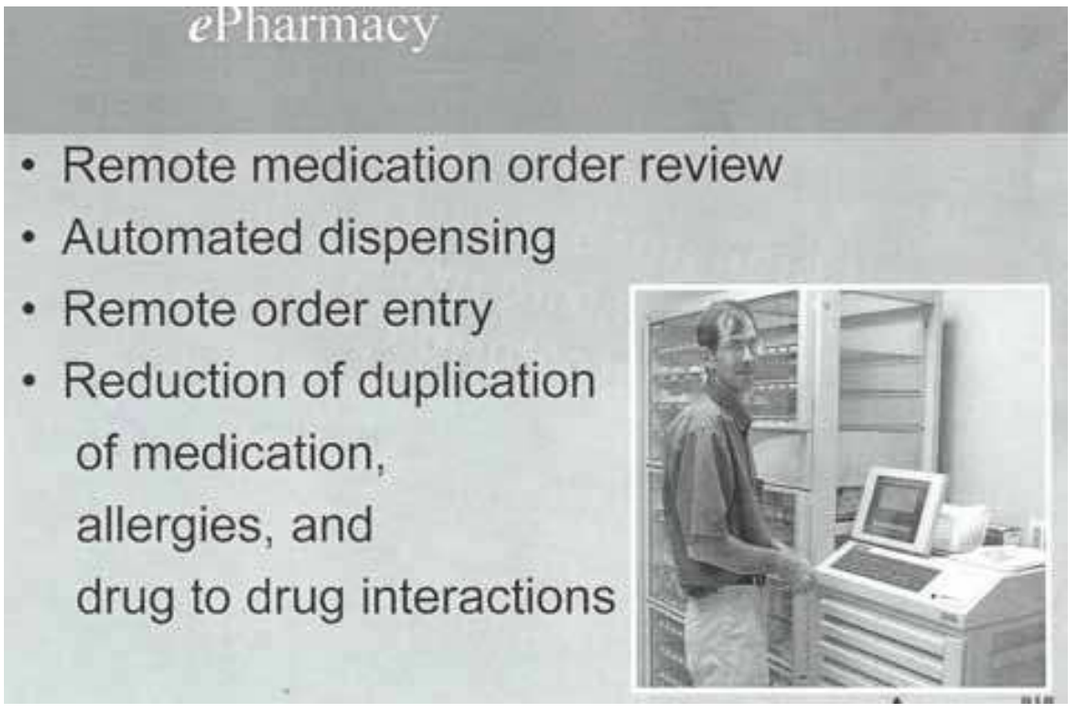


Fig. 6.

Figure 7 illustrates the growth (success) in utilization of this program over time. Numbers reflect interventions, not reviews of orders.

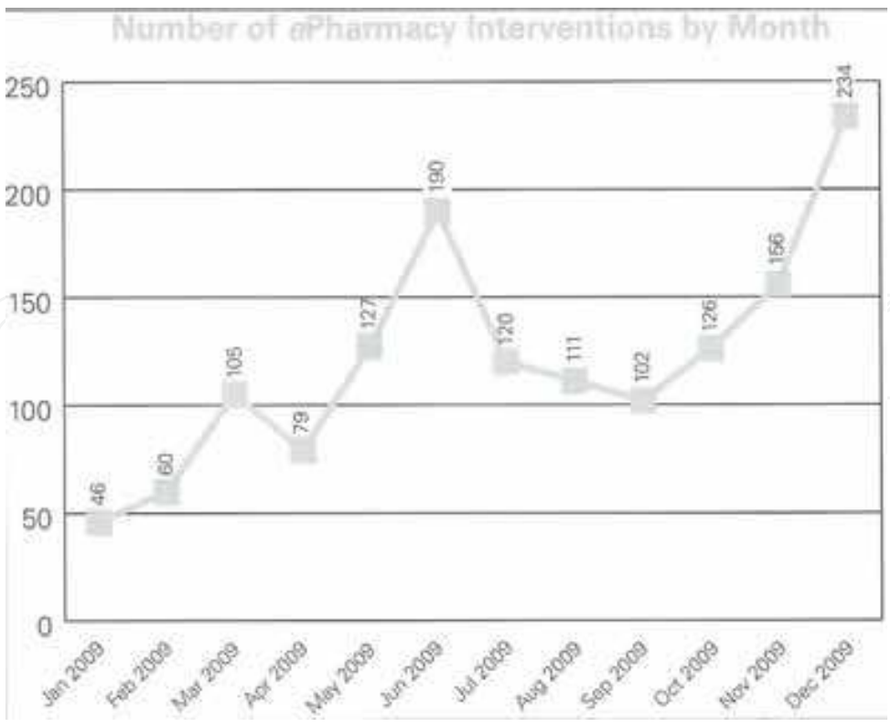


Fig. 7.

1.5 Electronic Emergency Services (eED)

The eED, also launched in 2009, has exploded in popularity with rural physicians. Figure 8 illustrates this program. The ability of the rural physician to have a resource to assist with immediate stabilization and triage decisions has been considered of utmost value in meeting an urgent need for problems which they have little time to prepare. Triage decisions are made in a timely manner, protocol initiation for such issues as goal-directed therapy as part of the Surviving Sepsis Campaign, thrombolysis for acute myocardial infarction patients with elevated ST-T electrocardiogram segments (STEMI patients), and therapeutic hypothermia preparation are examples.

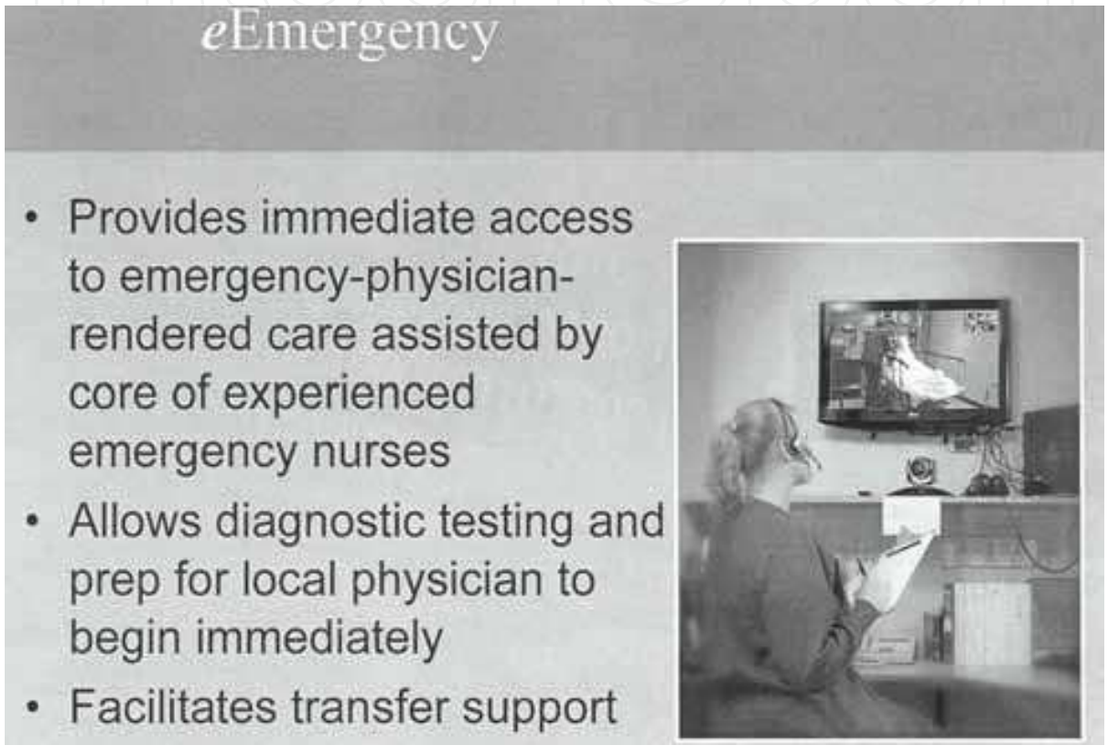


Fig. 8.

Figure 9, the circle graph the diagnostic diversity of the patients in whom eED has assisted.

1.6 Mobile Units

The eICU® vendor made available a mobile unit in 2007. As it was demonstrated to our rural sites, it quickly became a way to create flexibility for use in their hospitals. By wiring rooms in several locations, they could have patients monitored in their "emergency room," during a "rapid response," or on different floors of their hospitals. Even at our tertiary care hospital the mobile units have been used in a similar way. They are available for "rapid response" and to create "step-down" type of supervision for patients such as trauma or general surgery patients who have been transferred out of the ICU. In this way the mobile units can help with throughput of critically ill patients to avoid situations where no beds are available for new admissions or bounce back patients to the ICU. Figures 10 and 11 illustrate a mobile tele-intensivist unit.

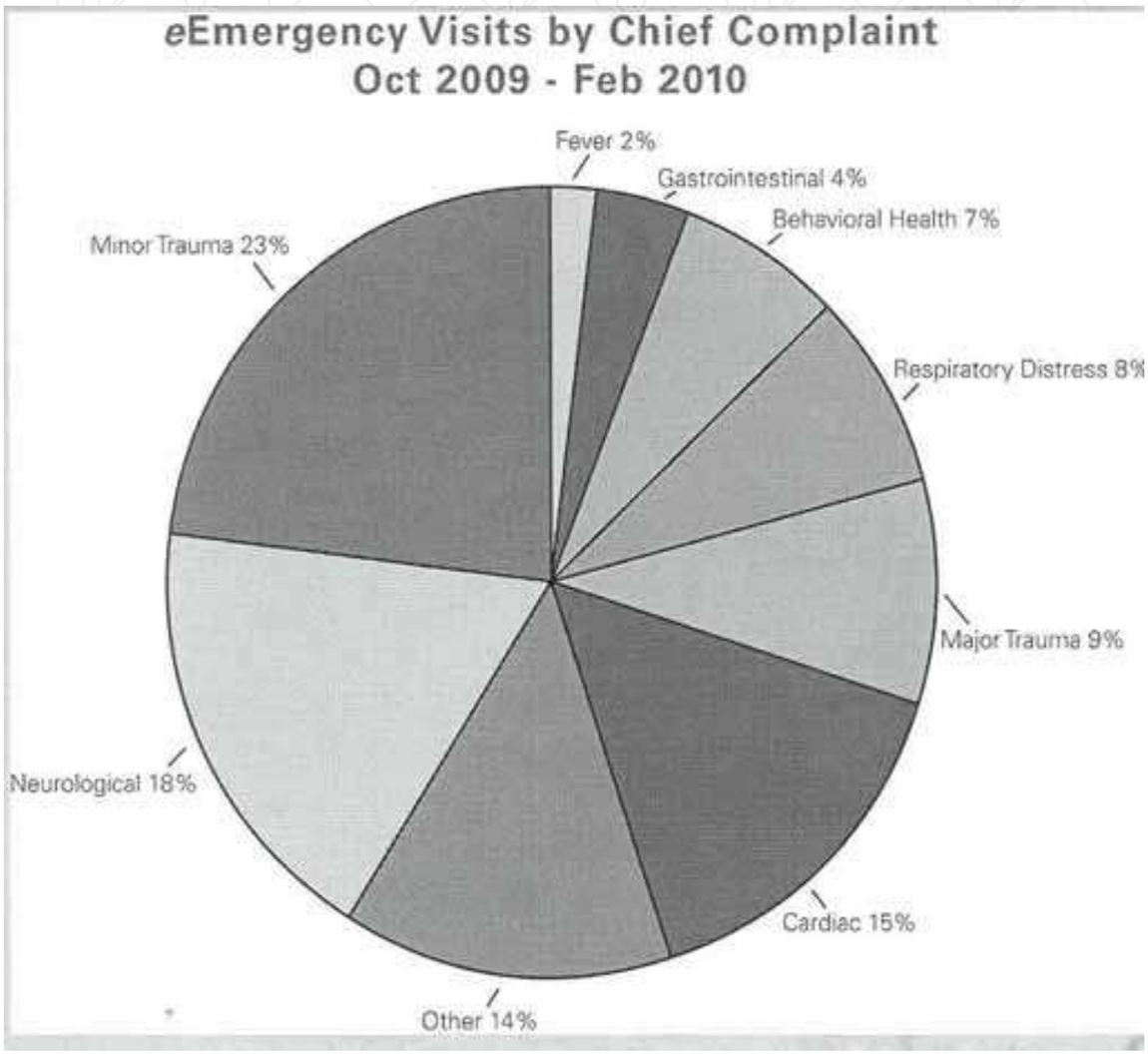

eEmergency Visits by Chief Complaint
Oct 2009 - Feb 2010
Fever 2%
Gastrointestinal 4%
Behavioral Health 7%
Minor Trauma 23%
Respiratory Distress 8%
Major Trauma 9%
Neurological 18%
Cardiac 15%
Other 14%

Fig. 9.

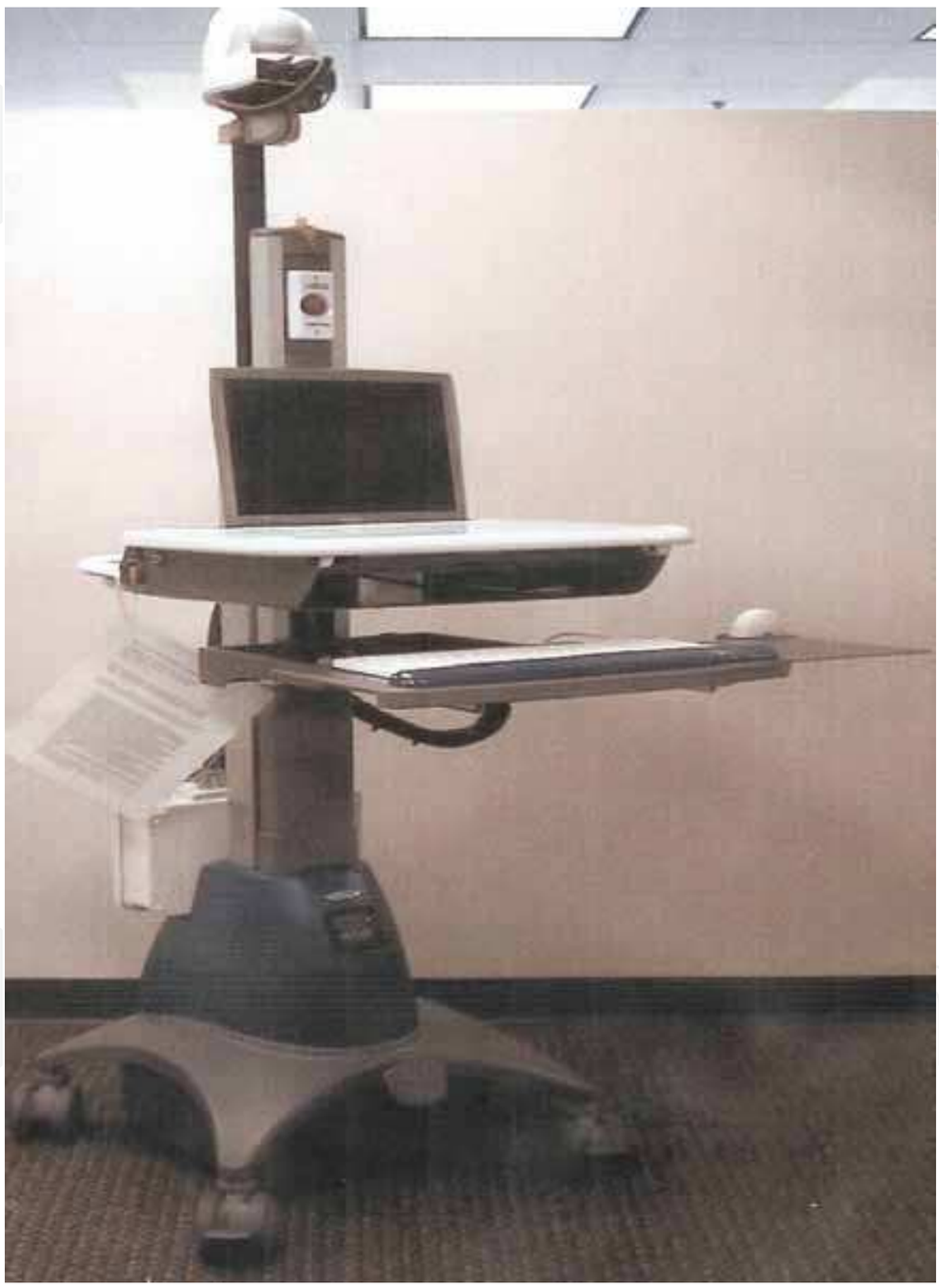


Fig. 10.

Fig. 11.

1.7 Two-way video

Two-way video was implemented in our newer tele-intensivist sites as of 2007 since it was a later upgrade by the vendor to their product. Figure 12 illustrates the two-way video screen which appears in the core control center when activated in a given patient room. Feedback from our patients and staff as well as that from other eICU®'s around the country confirms that patients and staff feel more reassured and supported by being able to view the remote staff who are assisting with surveillance and the execution of their care plan and most especially when responding to critical changes in clinical course.

Fig. 12.

1.8 Partners from other health systems

We expanded from our initial regional hospitals all in one state to multiple smaller hospitals including critical access hospitals. This growth was extremely successful but also created new challenges. One problem was the need to have physician and nursing licensing for multiple states and credentialing of each eICU® physician at each institution. In our case that means a staff of 8-12 intensivist physicians (some are part-time) need credentials in soon to be 27 hospitals. Also, to access patient databases at each hospital, multiple passwords and sign-on directions are required. This was especially true when we contracted for services to hospitals in other Health Systems. In those cases there might even be different servers for the patient

databases which required different navigation training. When monitoring patients from different health systems, there was often a greater need to build relationships from the eICU® team to local caregivers. Because of a lack of prior interactions, there was no basis for trusting the care provided by the tele-intensivist nursing and physician staff. As a result there were episodes of local provider resistance to the telemedicine supervision of their patients until trust grew from excellent outcomes as a result of co-management of dangerously ill patients.

1.9 Operating in multiple states

The biggest issue in operating in multiple states is nuances with licensure. Different states have different requirements for background checks, fingerprinting, and depth of education certificates that must be forwarded. Some states require on-site visits to their licensing offices. There can also be legal restrictions to scope of practice which impair the full utilization of telemedicine capabilities in that state compared to others.

2. Outcomes

2.1 Severity scoring

One of the first benefits we experienced after launching our tele-intensivist program was the ability to track data now captured by the vendor's software which was previously not available to us. The eCare Manager™ began feeding back data after the first quarter of operation. For example, we began to compare severity scores of our patients not only in our tertiary care facility but also in each participating hospital. The severity scores from our patients were also compared to other sites in the country which were utilizing this product. At present there are more than 45 sites in the United States and approximately 10% of all critically ill patients are monitored at any one time by the same technology. APACHE ® III (Acute Physiology, Age, Chronic Health Evaluation) algorithms were used to define the predicted mortality risk for these ICU patients. The APACHE III database is used to estimate the mortality risk for individual ICU patients using chronic health status information, severity of illness on ICU admission, age, prior length of stay and ICU admission diagnosis. (APACHE is a registered trademark of Cerner Corporation). This tool calculates a severity score based on acute physiology that includes 18 measurements of vital signs and laboratory tests, age of the patient, Glascow neurologic score, and chronic comorbidities. In our first analysis of our patients with APACHE III software, we noted that our severity is comparable to any other site in this large database of patients and published our initial data reports (Figure 13).[1]

The vendor's software has now changed its severity scoring system to APACHE IV. Ongoing analysis of our markedly expanded population of patients reveal that the severity of all the patients in our monitored beds remained greater than a majority of the other sites to whom we compare ourselves.

2.2 Mortality

The APACHE scoring system has continuously been validated on a rotating database of over one million patients to be highly predictive of mortality and length of stay outcomes. Over the first few years we were able to determine that our actual ICU mortality was considerably less than predicted by the APACHE score.[1] In quarterly reports we consistently ranked the best among all of the eICU® groups across the country in actual to predicted ICU mortality, actual to predicted ICU length of stay, actual to predicted hospital mortality (for the group of patients who spent part of their hospitalization in the ICU), and

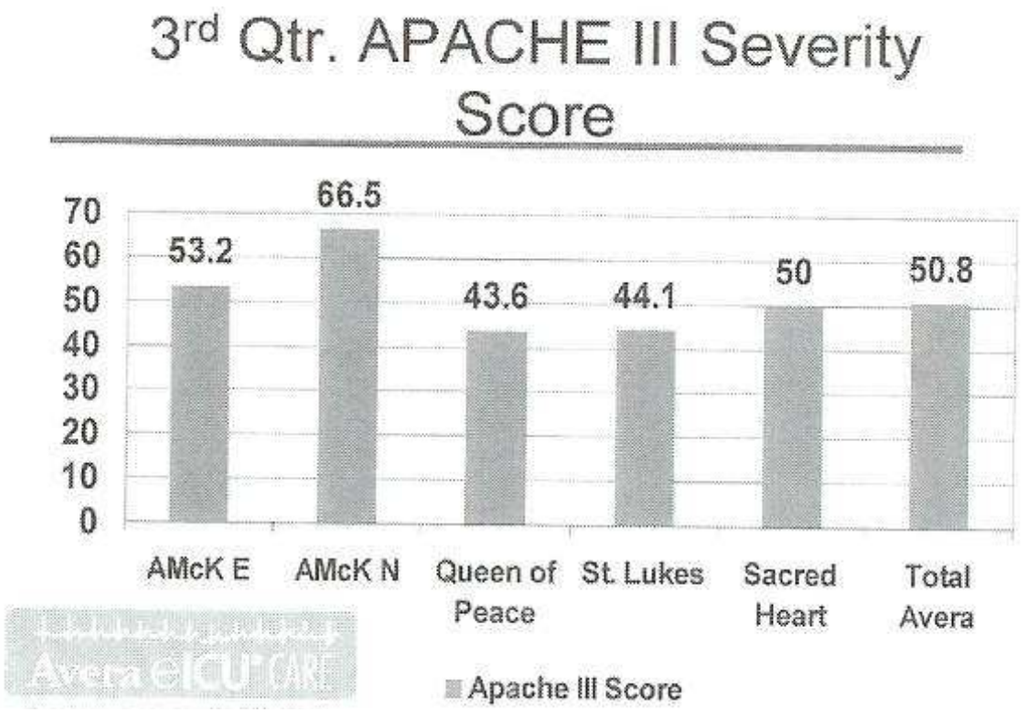


Fig. 13.

actual to predicted hospital length of stay (for the same group of patients). It was not clear whether these outstanding outcomes were due to the implementation of the tele-intensivist program. We therefore conducted a study in which we compared these measurements over the 2.5 year period after implementation of the eICU® to two year's worth of randomly sampled charts before the implementation.[2] Figure 14 demonstrates that there was a statistically significant improvement in these outcomes with the initiation of this telemedicine clinical program.

2.3 Lengths of stay

Since we were able to monitor our severity-adjusted actual to predicted ICU lengths of stay, we began to calculate the ICU days saved.[2] We continue to record this in our quarterly quality reports. Figure 15 illustrates this calculation before vs. after the project was begun. Since ICU length of stay has continued to be less than predicted we have also been able to calculate cost savings in the care of our seriously ill patients.

2.4 Ventilator days

Another important outcome we realized soon after the initiation of the tele-intensivist program was the improvement (decrease) in ventilator days. The 24-hour close supervision of patients allowed the weaning protocol to be facilitated by reassurance from the eICU® physician at all hours of the day or night. Figure 16 illustrates the reduction in ventilator days on average by 2 days. Even into our 6th year now, our average ventilator days still hover around 3.0 days.

We created a special program called eICU® ventilator rounds each afternoon to be described below which formally focused attention on weaning even before we had a bedside intensivist program.

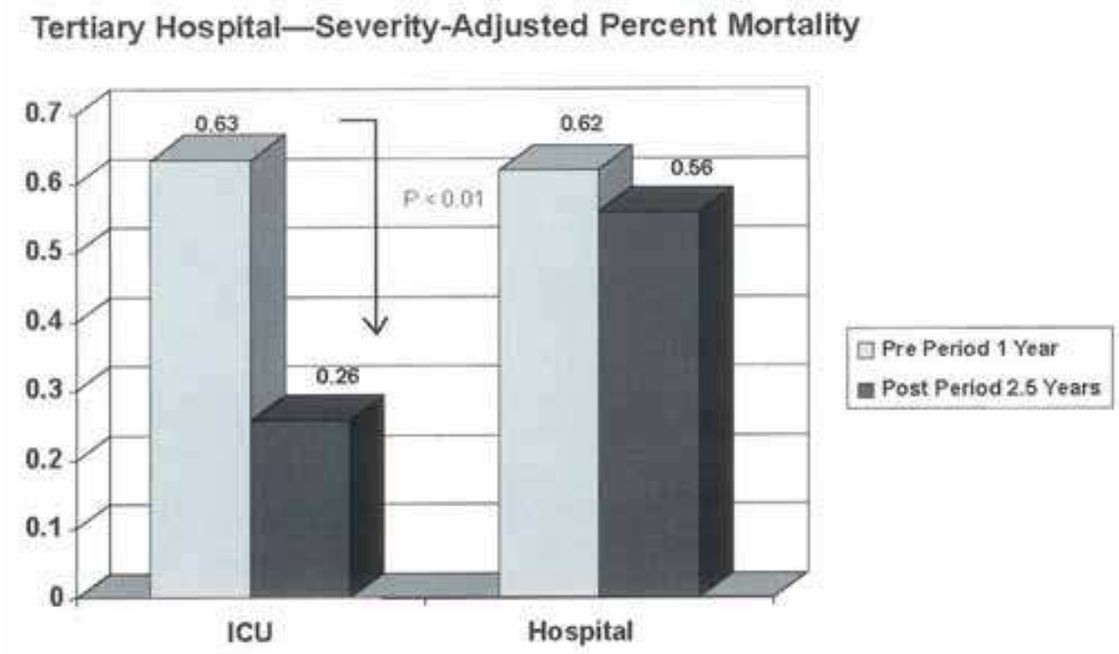

Tertiary Hospital—Severity-Adjusted Percent Mortality
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0.63
0.26
P < 0.01
0.62
0.56
ICU
Hospital
Pre Period 1 Year
Post Period 2.5 Years

Fig. 14.

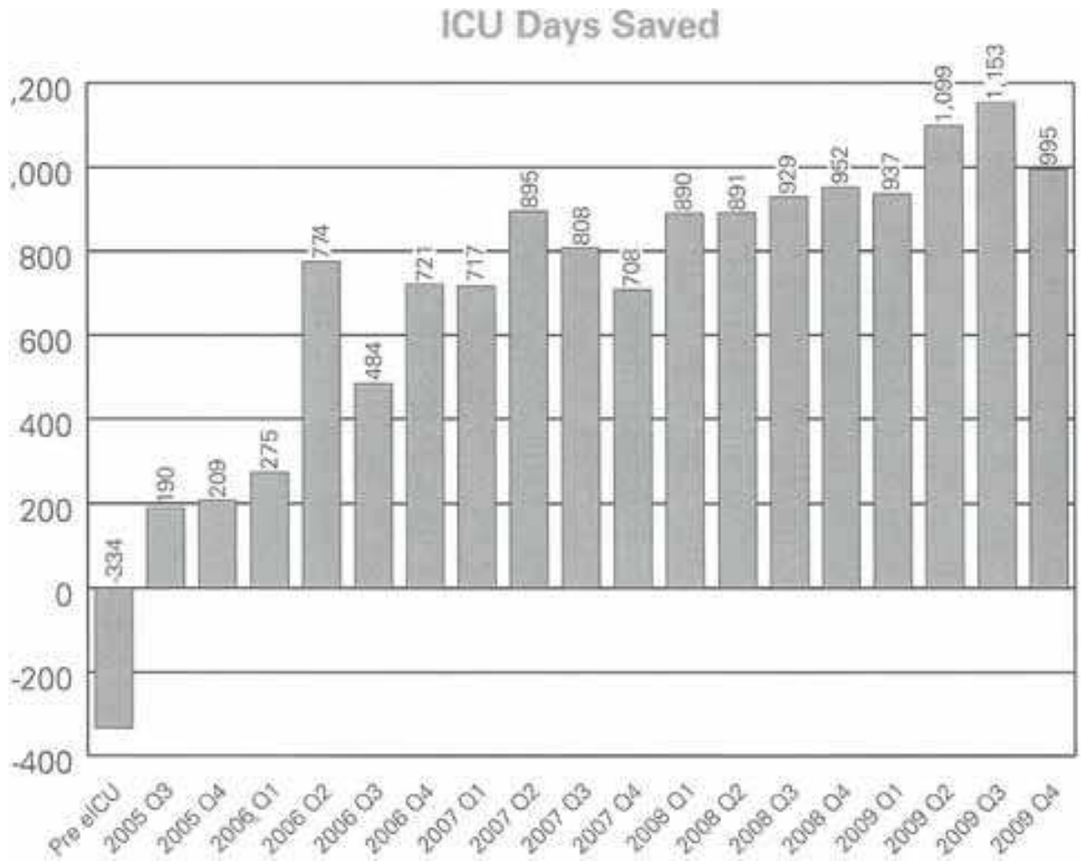

ICU Days Saved
,200
,000
800
600
400
200
0
-200
-400
-334
190
209
275
774
484
721
717
895
808
708
890
891
929
952
937
1,099
1,153
995
Pre eICU
2005 Q3
2005 Q4
2006 Q1
2006 Q2
2006 Q3
2006 Q4
2007 Q1
2007 Q2
2007 Q3
2007 Q4
2008 Q1
2008 Q2
2008 Q3
2008 Q4
2009 Q1
2009 Q2
2009 Q3
2009 Q4

Fig. 15.

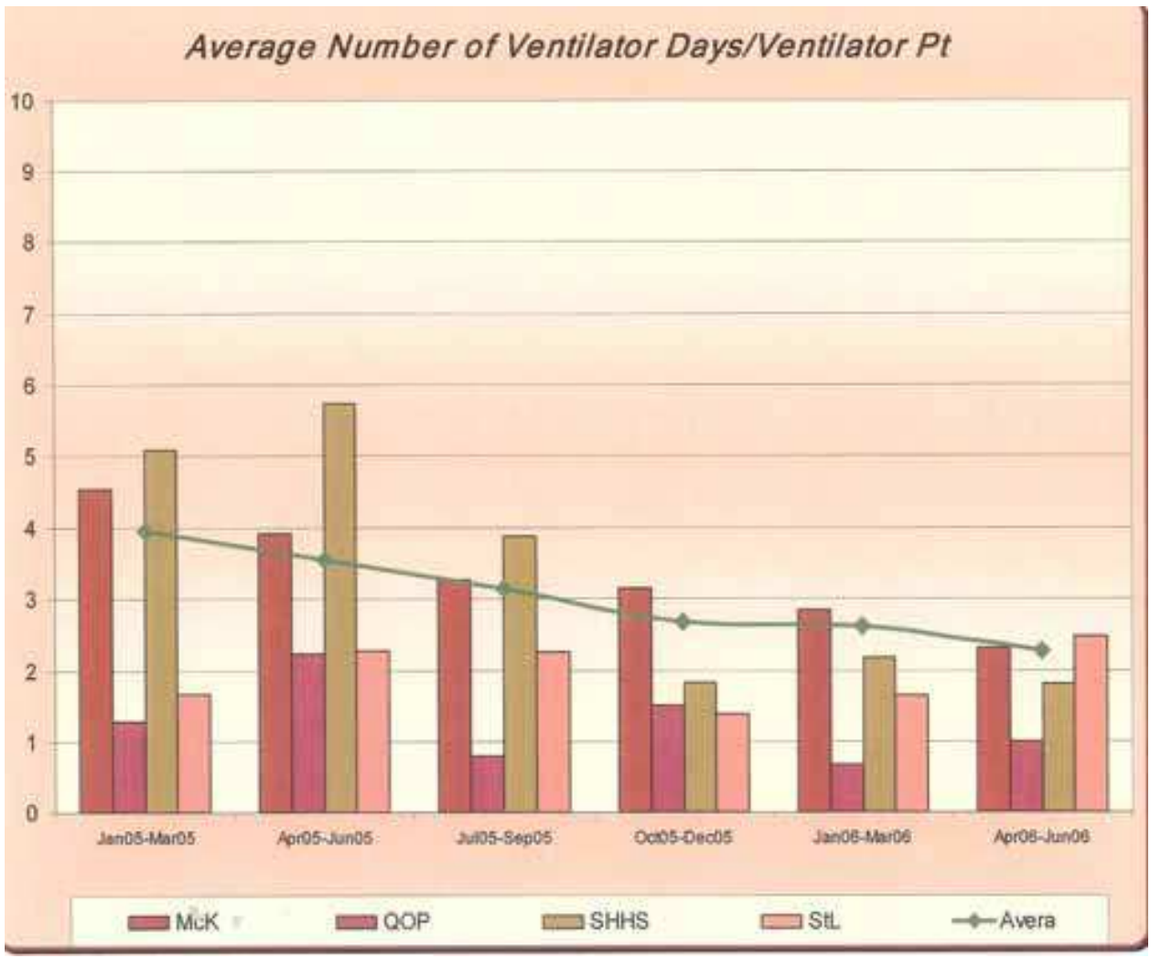


Fig. 16.

2.5 Transport savings

As a result of growing trust and comfort in having the assistance of the eICU® team, excellent satisfaction was voiced by remote providers and patients and families because many of them were able to remain in their local community. This satisfaction was documented by us in surveys and published in our second major publication of our experience.[2] As we investigated this benefit further we found that we could prove an enormous savings to the patients in our area through avoided transfer costs. Transfers would usually require helicopters or fixed wing transfers because of the geographic separation and severity of cases. Figure 17 estimated over a million dollars in such savings after implementation of the tele-intensivist program.

2.6 ePharmacy quality programs

Figure 18 demonstrates the influence of the ePharmacy program on quality of care. After implementation a variety of potential adverse events were avoided.

First-Year Fiscal Impact of Avera eICU® CARE

Hospital	Go Live Date	Total # of ICU Admits Since Activation	Avoided Transfers	Avoided Cost Per Transfer	Total Saved
Estherville	02/2006	36	5	$9,296	$46,480
Flandreau	08/2006	17	14	$5,697	$79,758
Marshall	09/2005	183	46	$8,234	$378,764
O'Neill	10/2005	35	10	$10,889	$108,890
Parkston	08/2005	34	17	$7,647	$129,999
Sioux Center	07/2007	7	2	$6,228	$12,456
Spencer	03/2006	74	62	$8,588	$532,456
Tyndall	09/2006	8	4	$7,644	$30,576
TOTAL				$64,223	$1,319,379

Fig. 17.

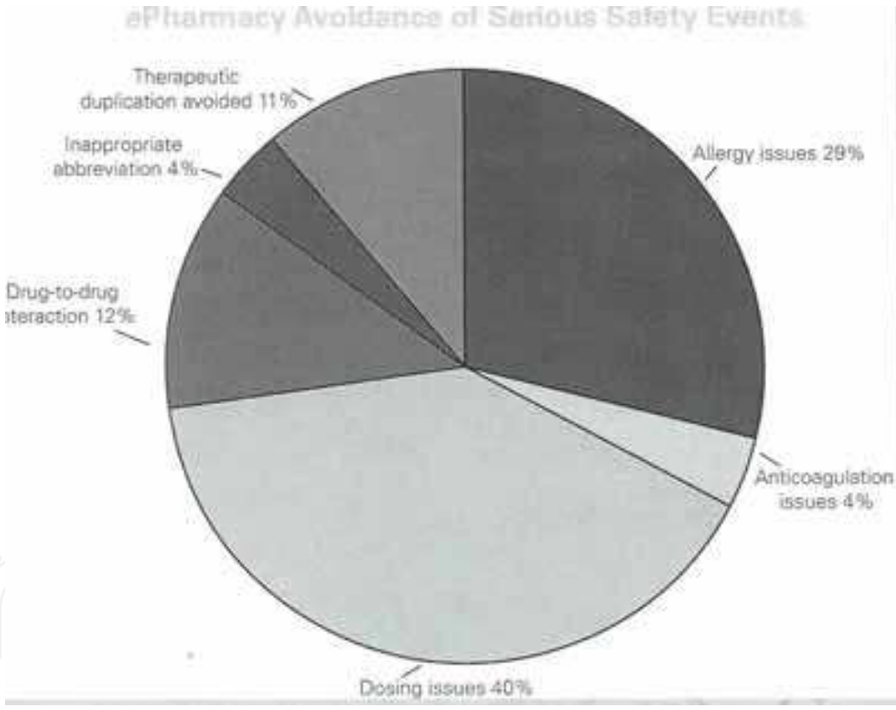


Fig. 18.

2.7 Special programs

Concomitant with launching of each component of telemedicine care, special focused projects to improve quality of care were incorporated into the daily routines. In the tele-intensivist program, the eCARE Manager™ prompted many best practice improvement strategies. For, example alerts appeared when deep vein thrombosis prevention and GI ulcer prophylaxis were not being addressed. In our 6 years of operation we also included 3 main internal projects: Ventilator Rounds, Glucose rounds, and Sepsis screening.

2.8 Ventilator rounds

Before our bedside intensivist program was launched, we performed daily multi-disciplinary ventilator rounds at 2:00 p.m. The eICU® physician activated the camera in each patient room sequentially where the bedside nurse and the assigned respiratory therapist reported on the progress with weaning. Families were involved as they were available. In patients who were hemodynamically stable, we ensured that sedation had been stopped for a time, that weaning parameters were measured off controlled mechanical ventilation, and also verified the ability of the patient to handle secretions and protect the airway. Any barriers to weaning were identified with a plan for solution. As mentioned above, there was quickly seen a significant reduction in ventilator days.

2.9 Glucose rounds

Each evening shift in our eICU®, the physician began Glucose Rounds which consisted of a systematic evaluation of the degree of control of glucose levels in our most seriously ill patients likely to remain in the ICU for several days. If control was not near a target for mean daily glucose less than 180 mg/ dL, more aggressive therapy was prescribed. An example might be a switch from sliding scale subcutaneous insulin to a constant insulin infusion. In this way we were able to lower our mean daily glucose for the entire unit from a mid 140 mg/ dL range to an upper 130 mg/ dL range.

2.10 Sepsis screening

A team approach to early sepsis detection has also been included in our daily workload. To ensure compliance with the Surviving Sepsis Campaign, we decided to use both the software alerts and an initial screen by our eICU® nurse to fill out a form which documented SIRS criteria in every patient admitted for our supervision. Those patients with SIRS criteria are reviewed by the physician for evidence of infection. If found, the intensivist ensures that early goal directed therapy has been initiated and choice of antibiotics is appropriate.

2.11 eStroke

At the time the eED project was being planned, several national initiatives (even ACLS guidelines) were launched to identify candidates for thrombolysis in stroke patients. Also during that time the emergence of stroke teams occurred in many hospitals to rapidly respond with multidisciplinary care for any hospitalized patient with a possible impending cardiovascular event. It was therefore a natural development that such a team could be summoned through telemedicine activity. Figure 19 illustrates the eStroke program which has become an important part of the eED effort.

3. Financing

Initially our programs were funded solely from our participating sites by an initiation fee and then by monthly support based on the number of beds which were supervised. The initiation cost covered the hardware fees, any vendor's software and management support fees, and the time required by information technicians and nursing and physician staff to launch each new site. The subsequent monthly requirement was needed to cover salaries of health care technicians, Pharm.D.'s, critical care or emergency department nurses, and intensivist or emergency department physicians. No charges were made to any patient or

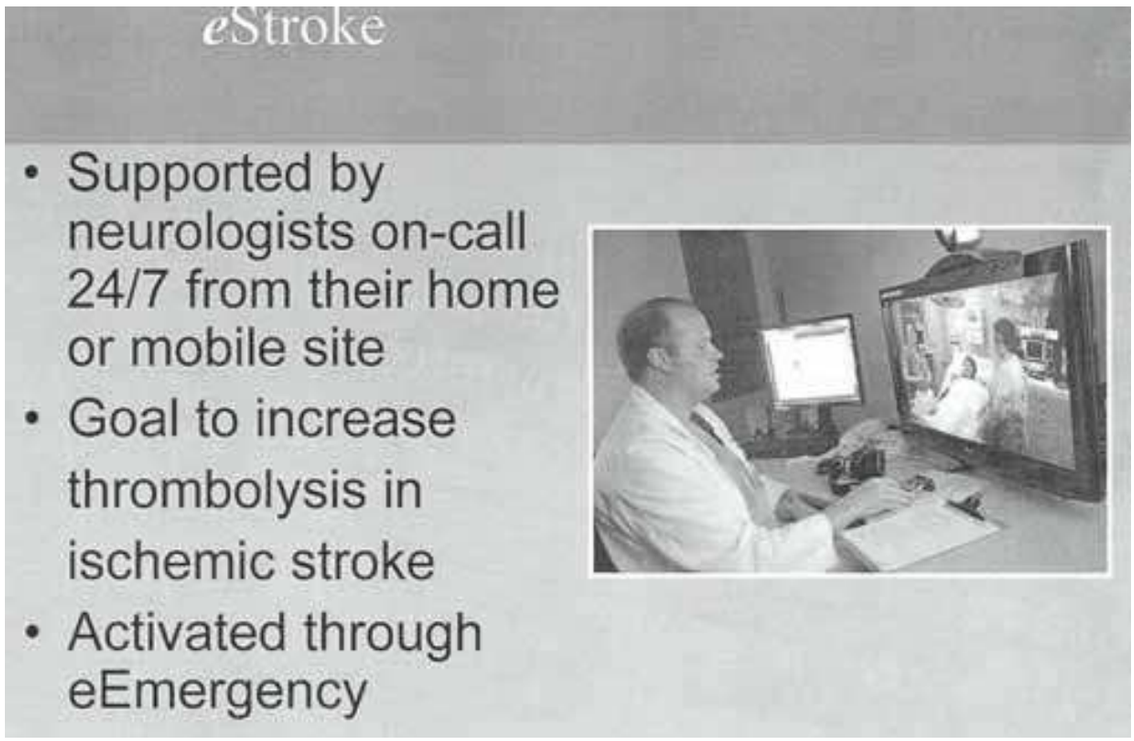

eStroke
• Supported by neurologists on-call 24/7 from their home or mobile site
• Goal to increase thrombolysis in ischemic stroke
• Activated through eEmergency

Fig. 19.


Funding
Grants awarded since 2005:
• Office for the Advancement of Telehealth, Telehealth Resource Center Grant
• 7 U.S. Department of Agriculture, Distance Learning and Telemedicine Grants
• Office of Rural Health Policy Network Planning Grant
• Office of Rural Health Policy Outreach Grant
• 3 Grants from the South Dakota Department of Health
• 2 Grants from private foundations
• Federal Communications Commission Rural Health Care Pilot Program Awardee
• Center for Medicare and Medicaid Emergency Divergence Grants
More than $21 million total grant dollars garnered

Fig. 20.

third-party payer. The programs were basically supported by the cost savings from the prevention of complications, the improved throughput of patients, and the reduction of numbers of outliers for any given diagnosis-related group (DRG).
The telemedicine effort of our institution has met the needs of our rural population separated by a vast geography whose mobility is often challenged by both distance and the threat of inclement weather. As mentioned patient and provider satisfaction has been excellent. The improved quality that has been demonstrated and the cost savings to rural medicine programs has been well received by granting agencies in the recent time of search for new health-delivery strategies. Figure 20 lists many funding sources which have enabled us to leverage expertise from the tertiary center to a great variety of hospitals and multiple different hospital departments.

4. Future considerations

4.1 Pediatric tele-intensivist care

The eICU® has received several requests for assistance with the care of pediatric patients, usually during urgent or emergent situations. These requests have resulted in a potential program aimed at this population. The pediatric tele-intensive care would consist of a dedicated e-Consult set up as described earlier but located not in the doctors' offices but at the pediatric intensivist work site adjacent to the tertiary care pediatric intensive care unit. Calls coming in are handled by the pediatric critical care nurses. They would involve the critical care pediatric nurse practitioner or intensivist physician as needed. Often arrangements for transfer to the tertiary care site will be made at that time. The pediatric intensive care team then can prepare the resources needed after the arrival of the patient and family. This program is expected to be launched within the next 12 months.

4.2 e-Labor and delivery program

Our tertiary hospital has had in-house obstetricians for a few years. These laborists are available to monitor patients in the hospital at any given time. They respond to calls from the emergency department in consultation to assist with care. Finally, they are available by telephone for calls from outlying sites. Setting up a telemedicine suite to assist with outside OB/ GYN procedures is being considered.

4.3 eHospital

eHospital services, monitoring non-ICU inpatients, has also been identified as a potential future program. Many of the smaller community and critical access hospitals have a limited number of providers in their communities to care for patients. Quality of life can be impacted by frequent after hours calls to these providers. Providing inpatient monitoring for an expanded number of patients could potentially provide support to these providers.

4.4 Concierge care

It has been envisioned that seriously ill patients who can afford to pay for a telemedicine station in their homes would desire such connectivity to a tertiary care team of specialists. It is also possible that federal agencies might be interested in extending telemedicine into the home to empower more patients to perform self care of serious illnesses. One such program which has been considered is the telemedicine supervision of home hemodialysis or nocturnal dialysis programs.

4.5 Airline emergencies

Airlines have desired to be more prepared for health emergencies in recent times as evidenced by the expanded availability of automatic external defibrillators (AED's). Several airline carriers have expressed interest in contracting for telemedicine services to supervise the management of in flight emergencies.

5. Part V. Summary and conclusions

In summary, telemedicine has been a good fit to leverage health care expertise in our health system and to neighboring partners because of the geographic separation of many sparsely populated towns and cities in the upper Midwest. Although planning began as early as 1993, the major growth has occurred in the past 10 years. From one on one consultation, the newer programs have provided specialty supervision by one team to an ever-increasing number of patients and sites in multiple health systems and multiple states. The quick acceptance and great satisfaction of the tele-intensivist project with its documented cost-effective care markedly catalyzed the development of similar services in other departments of the tertiary care medical center. Figure 21 summarizes how these multiple individual projects have now come to be coordinated in a effective and innovative telemedicine system of care.

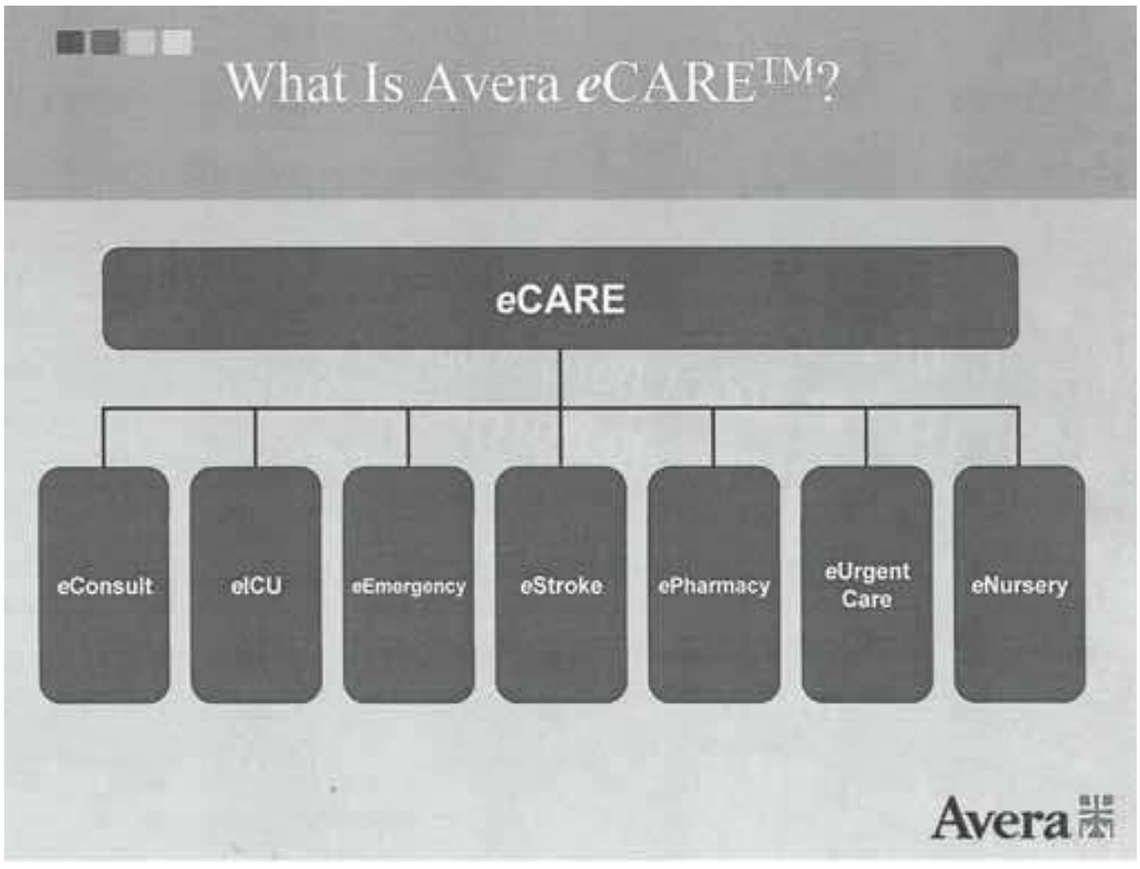


Fig. 21.

Figure 22 is a snapshot of the sites now covered by one or multiple of our telemedicine services at the present time. The eICU® alone will soon cover 28 sites with the capability of monitoring up to 117 seriously ill patients.

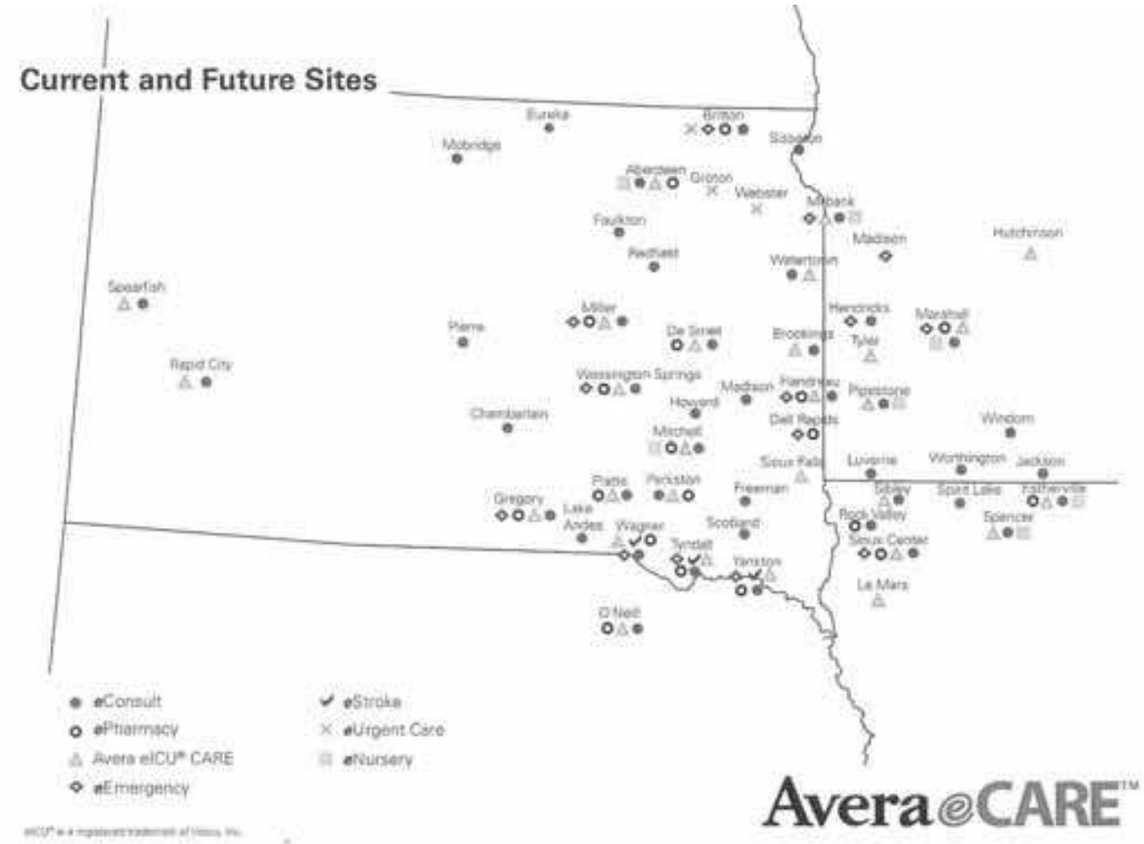


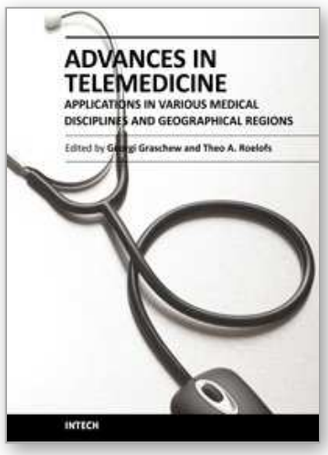
Fig. 22.

6. References

[1] Zawada ET Jr., Kapaska D, Herr P, et al: Prognostic Outcomes After the Initiation of an Electronic Telemedicine Intensive Care Unit (eICU®) in a Rural Health System. South Dakota Journal of Medicine. Sept 2006;391-393.

[2] Zawada ET Jr, Herr P, Larson D, et al: Impact of an Intensive Care Unit Telemedicine on a Rural Health Care System. Postgraduate Medicine 2009;121:160-170.

[3] Lilly CM and Thomas EJ. Tele-ICU: Experience To Date. Journal of Intensive Care Medicine. Sept 2009;1-7.



Advances in Telemedicine: Applications in Various Medical Disciplines and Geographical Regions

Edited by Prof. Georgi Graschew

ISBN 978-953-307-161-9
Hard cover, 296 pages
Publisher InTech
Published online 22, March, 2011
Published in print edition March, 2011

Innovative developments in information and communication technologies (ICT) irrevocably change our lives and enable new possibilities for society. Telemedicine, which can be defined as novel ICT-enabled medical services that help to overcome classical barriers in space and time, definitely profits from this trend. Through Telemedicine patients can access medical expertise that may not be available at the patient's site. Telemedicine services can range from simply sending a fax message to a colleague to the use of broadband networks with multimodal video- and data streaming for second opinioning as well as medical telepresence. Telemedicine is more and more evolving into a multidisciplinary approach. This book project "Advances in Telemedicine" has been conceived to reflect this broad view and therefore has been split into two volumes, each covering specific themes: Volume 1: Technologies, Enabling Factors and Scenarios; Volume 2: Applications in Various Medical Disciplines and Geographical Regions. The current Volume 2 is structured into the following thematic sections: Cardiovascular Applications; Applications for Diabetes, Pregnancy and Prenatal Medicine; Further Selected Medical Applications; Regional Applications.

INTECH
open science | open minds

InTech Europe
University Campus STeP Ri
Slavka Krautzeka 83/A
51000 Rijeka, Croatia
Phone: +385 (51) 770 447
Fax: +385 (51) 686 166
www.intechopen.com

InTech China
Unit 405, Office Block, Hotel Equatorial Shanghai
No.65, Yan An Road (West), Shanghai, 200040, China
中国上海市延安西路65号上海国际贵都大饭店办公楼405单元
Phone: +86-21-62489820
Fax: +86-21-62489821

IntechOpen