Cerner Millennium™: The Innsbruck Experience

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Summary

Objectives: A Clinical Information System, serving more than 2,000 users was to be implemented at three hospitals of TILAK (Tiroler Landeskrankenanstalten GmbH), including the University Hospital of Innsbruck. The system was intended to integrate data from radiology, laboratory, and pathology subsystems with patient data.

Methods: Using Cerner Millennium™ software and Health Level 7 standards, the first stage of an Electronic Patient Record (EPR) was built. Direct data entry was facilitated using either a Microsoft Word text processor (with subsequent authentication workflow) or structured forms. An enterprise-wide scheduling module allows coordination and storage of patient appointments directly in the EPR. As required by security policy, the Cerner software regulates the varying degrees of information exchange among organizations and departments within the enterprise.

Results: First experiences indicate satisfactory acceptance of system functionalities. The introduction of Cerner Millennium at TILAK has achieved essential goals defined at the beginning of the project. Basic functionalities – free text documentation, standardized documentation, scheduling, and some parts of order entry – are offered in a user friendly manner. Integration with existing systems to complete the EPR has been successful using standard interfaces (HL7).

Conclusion: TILAK concluded that it was possible to successfully implement a Clinical Information System (CIS) developed mainly for the American market in a European healthcare environment. Some adaptations and functional extensions were necessary (e.g., the discharge summary "Arztbrief"). The system had enough flexibility to meet the requirements and specifications of European healthcare processes. A key factor of success was the establishment of a basic level of understanding and communication between the software vendor and the TILAK user community.

Keywords
Hospital information systems, clinical information systems, implementation strategy, case studies, electronic patient record

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1. Introduction

A publicly owned holding company, Tiroler Landeskrankenanstalten GmbH (TILAK) is based in Tyrol, Austria. Its six hospitals total 2,300 beds, with a staff of more than 6,000 persons, including more than 1,000 physicians. Of the six, the University Hospital of Innsbruck (UHI) is the largest, with 1,520 beds and about 4,700 employees. Each year, UHI treats 70,000 inpatients and 300,000 outpatients, and admits more than 400 medical students to start their study with the Medical Faculty. Its mission encompasses patient care, research, and education, and involves a wide spectrum of medical specialties on a high level.

Discussion began in 1995, regarding the introduction of a Clinical Information System (CIS) to replace the clinical functions of the existing hospital information system, Medizinisches Auskunftssystem (MEDAS). In addition to MEDAS, which fulfilled primarily administrative functions, other systems were in place, including a Picture Archiving and Communication System (PACS) and diagnostic systems such as laboratory, blood bank, etc. Thus, from the outset, attention was paid to standardized interfaces, such as Health Level 7 (HL7), that would support the integration of subsystems.

Following the decision to launch a worldwide search for a clinically focused system, UHI consulted with clinical staff and reviewed the literature (1-5) to define functionalities expected of the system and identify goals for the first two to four years. Their vision for the next five to ten years was to develop a multimedia Electronic Patient Record (EPR) within the hospital that could be extended to other health care providers.

The forces driving this vision included the need to improve quality, efficiency, and cost effectiveness. In 1997, Austria introduced a new hospital financing system, Leistungsorientierte Krankenanstaltenfinanzierung (LKF). Like the Diagnostic Related Grouping (DRG) system in the United States, LKF requires complete and correct documentation of diagnoses and procedures, affecting both financing and hospital management (6).

2. Objectives

The objectives articulated for the EPR included making it available 24 hours a day, 7 days a week throughout the hospital for all co-workers depending on their authorization. The main goal of the project was to improve the quality of patient care. Achieving this goal required placing medical documentation in the foreground, targeting the production of proactive alerts, reminders, and to-do lists and supporting knowledge management, standards, and guidelines. Administrative data became a byproduct of this documentation.

Objectives also included making the new CIS the central data repository for data from different sources and systems linked together by standardized interfaces. As such, the CIS would facilitate documentation and provide access to information supporting health care providers in their work and their medical decision making. One necessary objective stipulated tools to implement a security system to guarantee privacy and allow a high level of data protection.

To summarize, the functional requirements for the CIS to be implemented were wide ranging. Economic and technical con-

siderations made a minimum of different systems desirable. Ideally, one system would address functionalities and needs of different inpatient and outpatient departments. Moreover it is essential , if one wants to achieve an enterprise wide EPR, to have a single, centralized integrated patient data base (1, 7).

Among the many goals enumerated for the new CIS for TILAK were the following:

- implementation of an enterprise-wide multimedia EPR supporting
  - medical documentation
  - efficient data retrieval and data presentation
  - standard clinical business processes including resource planning and enterprise-wide scheduling
- replacement of existing systems, some of them non-serviceable, homegrown, and/or proprietary
- avoidance of new subsystems
- tight integration with PACS and the new Image Management systems supporting the ordering process as well as multimedia components within the EPR
- building up a central database
  - for scientific research
  - for quality assurance and continuous quality improvement
  - for a management information system on department level as well as on the level of the whole organization
- access to knowledge base and integration of knowledge management tools
- going in direction of e-health.

The functionalities were defined in requirement specifications, structured to allow for flexibility in the technical implementation.

3. Implementation Strategy

In 1999, the TILAK Executive Board and the Medical Faculty of the University of Innsbruck jointly decided to implement Cerner Millennium (8). As the central application for communicating and collecting information, the Cerner software would help make the vision of an enterprise-wide EPR a reality in the TILAK hospitals.

At that time, MEDAS had been recently improved and was already in use in patient administration and billing, including procedure coding. Also in place were PACS and a number of other systems, including those in diagnostic departments and the financial area. From the outset, these existing IT-solutions made it possible to feed the EPR with important information from previous years.

TILAK was aware of the potential risks and benefits involved in implementing an enterprise-wide CIS-project in cooperation with an American software vendor. Prior to the implementation at TILAK, the only Millennium installation in a German speaking country was in the Humboldt Hospital Reinickendorf in Berlin. Moreover, the project in Tyrol would be the first in a European university hospital. However, TILAK was convinced that Millennium held the greatest promise for realizing a multimedia EPR strongly supportive of medical processes.

For this important project, TILAK formed an internal, six-person IT-project team. In addition, TILAK joined with other partners to establish a specialized IT-consulting company, Information Technologies for Healthcare (ITH), in Innsbruck. Both teams received intensive training on Millennium from Cerner. Each team was led by a project executive, with its own project management to address short-term and project-internal decisions. A steering committee was formed to make strategic decisions; its membership consisted of hospital managers, IT-executives and representatives of the various user groups, including medical doctors and nurses.

The plan called for implementing Millennium over five years, from 1999 to 2003. The first year focused on recruiting and educating the two project teams and building up the complex software-system and interfaces to the Admission/Discharge/Transfer (ADT) system in MEDAS. At the end of 1999, Millennium "went live" with basic functionalities.

The Cerner software ran on an IBM server RS/6000 H70 before being moved to an M80. Allgemeines Rechenzentrum (ARZ), an IT-solution partner for banks and public institutions throughout Austria, was tasked with hosting the servers and system management. Innsbruck-based, ARZ offered a maximum of availability and security, in addition to the rapid response time essential for acceptance of the system.

Initially, the implementation plan consisted of three phases, each of them subdivided into pilot and rollout. Phase 1 provided functionalities primarily in the areas of documentation and information; phases 2 and 3 focused on communication and scheduling. The original plan was modified early in the implementation when the project teams became aware of missing software functionalities. As a result, the teams defined a "functional roadmap" displaying their objectives and requirements on the one hand and the Cerner software abilities and concepts on the other hand. The decision was made to add a pilot phase 4 in 2003 to provide more innovative functions.

The plan for 2001 called for implementing a package of available functions that had been extensively tested, including scheduling, result reporting via the core module of the EPR "Powerchart," nursing codes, and discharge documents known as "Arztbriefe." Introduction of this package required that each of the 40 clinical departments form its own small project organization, each designating contact persons for both the physicians and the nurses. Special focus was placed on high-level, professionally conducted training for end users. TILAK's health care education center, Ausbildungszentrum West (AZW) organized the training for physicians and nurses, using tutors from ITH.

TILAK adopted the implementation strategy of piloting new functionalities ready for rollout (e.g., PACS integration, diagnostic coding, ordering for new service departments, etc.) in selected departments. Functionalities were extended to other departments only after a period of successful use. Thus, project groups worked on two dimensions: first, implementing in new departments and, second, introducing new functionalities in clinics already using the system.

As implementation moved forward, the project teams learned valuable lessons. They recognized that a comprehensive implementation of order management –

a critical component of a complete CIS – would take years. Yet they anticipated that, as the numbers of users and functionalities increased, the benefits of order management would become more apparent.

They also realized that, in many cases, they would need to develop new interfaces to subsystems. Nonetheless, even in the earliest phase of the project, they introduced features supporting clinical processes, such as standards, guidelines, and basic decision support.

In the initial concept development period, the project teams identified the need to support communication between the hospital and external physicians, especially general practitioners. As planning proceeded, they realized that a central EPR containing authenticated documents would serve the base for mailing documents and findings electronically. Thus, establishing the CIS became the way to provide a central hub for extramural communication.

4. System Architecture

The intent at TILAK was to use the Cerner system for documentation and communication in all the medical specialties, with the exception of areas such as radiology and laboratory departments. The plan also called for replacing many of the small departmental research databases, most of which were on a MS-access basis without an ADT feed, and homegrown documentation systems, with customized applications provided by Cerner within Millennium. This strategy was based on the features of the Millennium architecture which provided the following as part of the EPR:

- a patient-centered view
- a workstation supporting task lists, communications, and active result reports
- an open architecture integrating data from various systems through configurable translation tables for foreign system specific data representations
- a data repository based data model which can be extended by parameterization by authorized users. Attribute information is stored in meta tables which can be accessed using the development tools
- forms and report generation capability
- accessible scripts for standard operations instead of "hard-coding"
- a multi-dimensional security model allowing different restrictions for the separation of organizational units.
- a three-tier client server architecture based on a standard Oracle database

Figure 2 portrays the technical complexity of Cerner Millennium (9). The client server architecture includes multiple software layers: the presentation layer, shown at the top as implemented in VB, VC++, etc.; the communication layers; the application server layer (called "business rules" in the graphic); and the database layer.

Among the systems considered by TILAK in its worldwide search, only Cerner Millennium offered an architecture integrating basic and advanced clinical functions in a single product suite with a common database:

- powerful integrated scheduling module
- integration of legacy and ancillary systems via HL7 possible
- decision support applications (expert system)
- integrated data warehousing capabilities which also can be used for clinical scientific research
- financial and management systems

Other advantages of the Cerner software cited by the TILAK team included its focus on workflow, user-friendly presentation and customizable presentation of clinical information (e.g. by building special views and filters for medical specialties or professions), and its emphasis on supporting healthcare processes towards improving quality.

5. Implementation

5.1 Integration with Master Patient Index and Ancillary Systems

The first step in implementing the EPR was to analyze the existing HL7-network at TILAK and identify which systems and messages should be connected to the Cerner Millennium system. The central point in the HL7-network of TILAK was the MEDAS system, which included the master patient index and was the hub for all ADT transactions. In addition, MEDAS served as a message filter. Findings from radiology and laboratory were first sent to MEDAS, which checked for consistent patient data. If the patient and the encounter were consistently identified (using patient-ID and encounter-ID), the message was accepted and routed to a Cloverleaf communication server. The server then forwarded the results to "interested" systems, using the configured routing tables. For example, a laboratory finding might be routed to Cerner Millennium or, depending on criteria, to the Nexus Medfolio system for radio oncology (Nexus GmbH Germany).

By end of 1999, the Cerner system was integrated with MEDAS and the radiology and laboratory systems. After a historical upload of the master patient index, numbering approximately 800,000 patients, and all encounters, Cerner Millennium contained online synchronized patient data. As the first stage of a multimedia EPR, it presented the data in its client application, Powerchart. Table 1 provides an overview of the interfaces currently implemented at UHI and two other TILAK facilities.

Plans for 2002 called for added integration, making pictures from PACS and the new Image Management available by sending the picture links to Cerner Millennium. The link will be displayed in Powerchart with findings and values; a click on the link will launch an external (system definable) viewer application showing the selected picture.

5.2 Free-Text Documentation

The implementation of active documentation, using Millennium applications rather than interfaces, started midyear 1999 (10). Focused on free-text documentation, the first stage went live in two pilot clinics, the

Table 1 This table gives an overview on the interfaced systems. Each data feed is associated with an "organization". "Organizations" are Millennium's concept to keep data from different organizational units separated. By assigning users to organizations, the administrator grants access to the organizations' data such as encounters, findings, etc. For technical reasons, each interface splits into a number of technically distinguished feeds (e. g., outpatient vs. inpatient).

System	Organization	Description
ICOSERVE	University Hospital Innsbruck	Reference pointers to PACS pictures stored in ICOSERVE image management system
Laboratory	University Hospital Innsbruck	Results from PG-Medlab (PG-Softline) laboratory systems
Blood Bank	University Hospital Innsbruck	Results from PG-Medlab blood bank system
Pathology	University Hospital Innsbruck	Results from clinical pathology
Radiology 1	University Hospital Innsbruck	Results from Medora RIS (Innomed) system
Radiology 2	University Hospital Innsbruck	Results from MagicSAS RIS (Siemens) system
MEDAS LKI	University Hospital Innsbruck	ADT messages incl. patient merge and update
OP-Dis	University Hospital Innsbruck	Surgical data and diagnoses from Op-DIS (C.a.r.u.s.) theatre management system
MEDAS HOZ	Hospital Hochzirl	ADT messages incl. patient merge and update
MEDAS NAT	Hospital Natters	ADT messages incl. patient merge and update
MEDAS PKH	Hospital Hall	ADT messages incl. patient merge and update
MEDAS LPT	Nursing Home Hall	ADT messages incl. patient merge and update
MEDDOC UPL	University Hospital Innsbruck	Upload feed: findings from replaced subsystem
Hygiene	Institute for Hygiene	Results from PG-Medlab laboratory system

Department of Neurology and the Department of Orthopedics, in December 1999. However, the software release then available had two significant drawbacks: first, it provided no MS-word integration; second, it provided unsatisfactory support for the complex correction and authentication processes required of clinical documents. Authentication, it should be noted, plays a critical role in how communication is organized in European hospitals.

In midyear 2001, a completely new release for clinical free-text documentation became available, offering MS-word integration and considerably more flexibility for the authentication process. The 2001 release also offered new capabilities for the interactive selection and importation of patient-specific clinical data such as lab results. This release was first tested in the pilot departments and then, after some refinements, introduced into other clinical departments. By early 2002, this functionality had been implemented in eight clinical departments. Given the different organizational structures and hierarchical structures in those departments, the flexibility provided by the new release was essential.

5.3 Structured Documentation

The implementation plan specified using Powerforms, the structured documentation module in Millennium, as the central tool for data entry. Well defined variables would allow detailed analysis and further processing of clinical data for decision support as well as statistical or epidemiological analyses. They would also aid reporting in the Open Management Foundation (OMF) module. User defined variables can be built by adding new fields and their ranges to the meta tables containing the conceptual data model. The intent was to replace existing customized "research databases," most of which were on MS-access basis, and to switch documentation from free text to direct structured data entry wherever possible. Long-term goals included developing a detailed data model and a comprehensive data dictionary.

The first pilot occurred in a vascular surgery outpatient department, where the move to structured documentation emerged as a major organizational issue. Under the free-text system, findings were dictated by the physician, transcribed, and entered into a correction and authentication workflow. In contrast, structured documentation required the physician to enter structured findings. The change increased the workload for the physicians, who felt that the new system required too much time (several minutes). Requiring physicians to use a computer to enter data proved difficult as well, raising human factor issues. Eventually, the department switched back to dictation. For the project teams, this experience highlighted the importance of reorganizing established processes when introducing CIS.

As a result, when the teams implemented structured documentation for a new emergency department in October 2001, they took a different approach. One single form presented all data in selection lists deliberately chosen for predefined contents. Data entered directly by the physician produced the initial documentation for the patient. Upon transfer or discharge, the system generated a free-text document prefilled with the discrete data according to the structure of the document (e. g., diagnosis, anamnesis, therapy). This document then could be supplemented by dictation, if desired, before being finalized in the usual review-sign workflow.

Structured documentation was also implemented successfully for outpatient nursing documentation, used primarily in the emergency department. To date, these complex forms have been well accepted, most likely due to the care with which they were designed. According to a recent study, the emergency department used electronic nursing documentation for 95% of their patients.

5.4 Ordering

The project teams planned to implement electronic ordering in the UHI radiological departments to support their role as central service providers for three TILAK hospitals. After a pilot in Neurology, demonstrating the functionality and flexibility of Millennium, the teams began to roll out the system on a wider basis. Soon, however, serious organizational issues arose.

The paper-based ordering process was based on the division of labor. The nurse prepared the form, affixed patient labels on it, and entered some information; the physician completed the order (i. e., entered the

diagnosis and problem) and signed it. Because the electronic process and automated patient identification eliminated the need to fetch paper forms and affix labels, the nurse was no longer involved. Although the software could have supported a split process, the entire process became the responsibility of the physician. The result was an increased workload for the physician, who had to select the patient from a patient list or search by name, identify the type of order, and fill out all details.

Shifting work from the nurses to the physicians created strong resistance in some areas. After several attempts to work with mediating groups and management to resolve the issues, the project teams realized that a complete roll out of electronic ordering would not be possible. However, clinicians who had accepted electronic order management for radiology were eager to have as many service providers electronically available as possible, to give an overview of a patient's orders in a single media.

Again, the project teams learned valuable lessons. After this experience, they changed strategy, starting projects only in departments where it was clear from the very beginning that the changed workflow would be accepted by nurses and physicians. If there was any doubt whatsoever, they postponed implementing order management. In these instances, they also analyzed what electronic service providers should be implemented to provide a high level of coverage.

Under this change in strategy, the teams moved from making a central service provider electronically available in all departments, to making the most important service providers electronically orderable in selected departments. Given that UHI has more than 180 cost centers which are service providers, it would take several years to implement complete coverage with electronic ordering.

5.5 Scheduling

Pilot implementations of Millennium scheduling occurred in two pilot outpatient departments at the end of 1999. The first, Orthopedics, had prior experience with electronic scheduling in a program that was not Y2K compliant. The second, Neurology, had used paper appointment books only. The two pilots demonstrated that Millennium's electronic scheduling was flexible and could be customized to ease the shift from paper, even for personnel with limited computer experience.

After a pilot testing and refinement phase of four months, the project teams launched rollouts across UHI. Each rollout began by contacting the department head and reviewing software functionalities together to determine how electronic scheduling could be useful. Nearly every outpatient department and diagnostic unit indicated a need for electronic scheduling.

After identifying with the end users the resources for which scheduling should be implemented, the project teams began the design meetings. The success and the speed of the implementation correlated strongly with the organizational quality of the department. Departments that were able to give good totals on numbers of patient (new, checkup, and internal) and duration of different appointment types needed fewer "optimizations" after implementation. In some departments, however, the scheduling had to be completely redesigned after introduction.

Overall, the scheduling functionality and its rollout were highly successful. For example, real time check-in and check-out improved the quality of ambulance organization. The electronic appointment book gave end users a fast overview of patients waiting in the examination rooms; moreover, it was always available and at hand, unlike a paper appointment book. Another benefit was the reduction of the patient's waiting time due to now exactly timed appointments rather than estimated appointments.

Figure 1 shows the appointments booked each month in the system and the increase over the rollout. In November 2001, the number of appointments booked in the system totaled approximately 35,000 for the month. The increased use of electronic scheduling has the capability to provide additional benefits through "cross booking." Under cross booking, when there is an existing relationship between two departments, the service provider can assign a quota of a given resource to a dedicated requestor, allowing the requestor to book appointments directly into the service provider's resource, avoiding time-consuming telephone calls and negotiations.

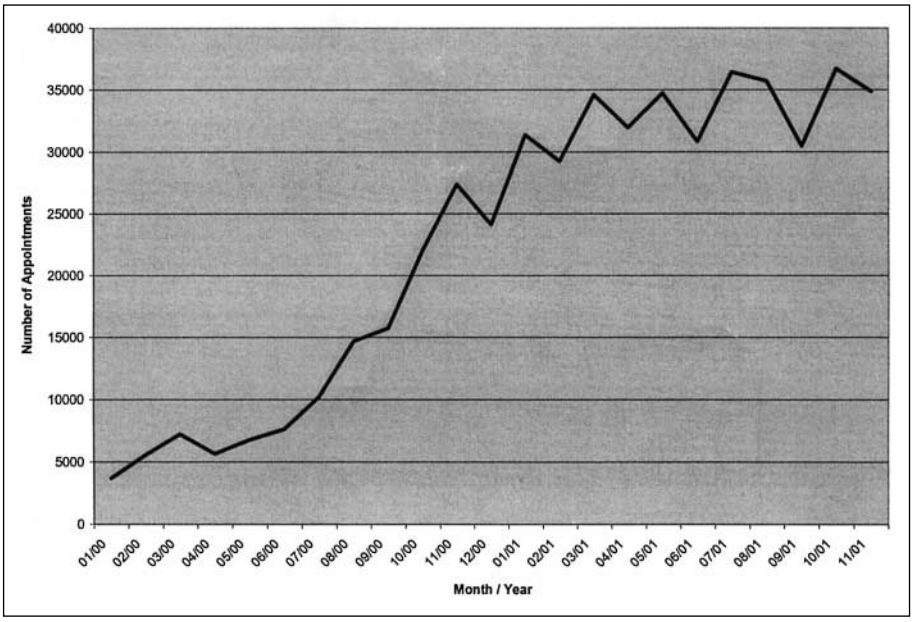

Fig. 1 Increase of monthly appointments during rollout. It shows the increase of the number of appointments booked every month in Cerner Millennium. The rollout of electronic scheduling started in April 2000 and was finished for the most part by midyear 2001.

6. Experiences

Midpoint in the implementation of Cerner Millennium, TILAK and the project teams reviewed their experiences in installing and using the software.

6.1 The Cerner Software

A CIS based on Cerner Millennium could provide the first stage of an enterprise-wide EPR. The flexibility to interface with other systems, using the HL7 standard, eased the process of integrating clinical data from ancillary systems into one single database, as documented in Fig. 2. The capability to allow data entry directly into the system using either standard text processors or structured custom forms made it feasible to establish Millennium as the clinical workstation for the majority of clinical departments. Even for medical specialties like dentistry or ophthalmology that required specialized software from specialized vendors, the focus was on feeding data from those systems into the central EPR in Millennium.

The strength of Millennium was found to be the inclusion of basic and advanced functionalities in a tightly integrated suite of products using the same database. This allows for the support of clinical business processes which involve a series of operations of different types. Because one database was used, scheduling, admission, ordering, executing a task, and starting clinical documentation yielded an integrated view on all results of the diagnostic and therapeutic process.

Severe problems arose when changing regulations imposed by law or by social insurers had to be addressed. For example, admitting an inpatient and billing after discharge required the implementation of country-specific billing algorithms which are much easier to realize in a custom programmed administration system such as MEDAS.

Nonetheless, TILAK concluded that it was possible to successfully implement a CIS developed mainly for the American market in a European healthcare environment. Some adaptations and extensions were necessary (e. g., the discharge letter "Arztbrief"). Overall, the system had enough flexibility to meet the requirements and specialties of European healthcare processes, once TILAK and the software vendor had established effective communications. However, significant benefits could be drawn from the advanced functionality developed for the currently more advanced American market.

Implementation of some functionalities was successful. By early 2002, almost 150 outpatient units were using the electronic scheduling system. Powerchart was widely accepted and broadly used to present patient related information in the EPR, with more than 2000 users registered in early 2002 and 3,000 expected. The first clear benefits resulted from these two functionalities. Cross-booking between departments facilitated coordination of complex treatments, and the availability of the EPR via Powerchart showed great value, especially in the emergency departments. Some departments were using Powerchart with projection equipment for their morning rounds, and early use of mobile laptops and tablet-PCs connected to the network via wireless LAN offered the promise of extended use of Powerchart on the wards.

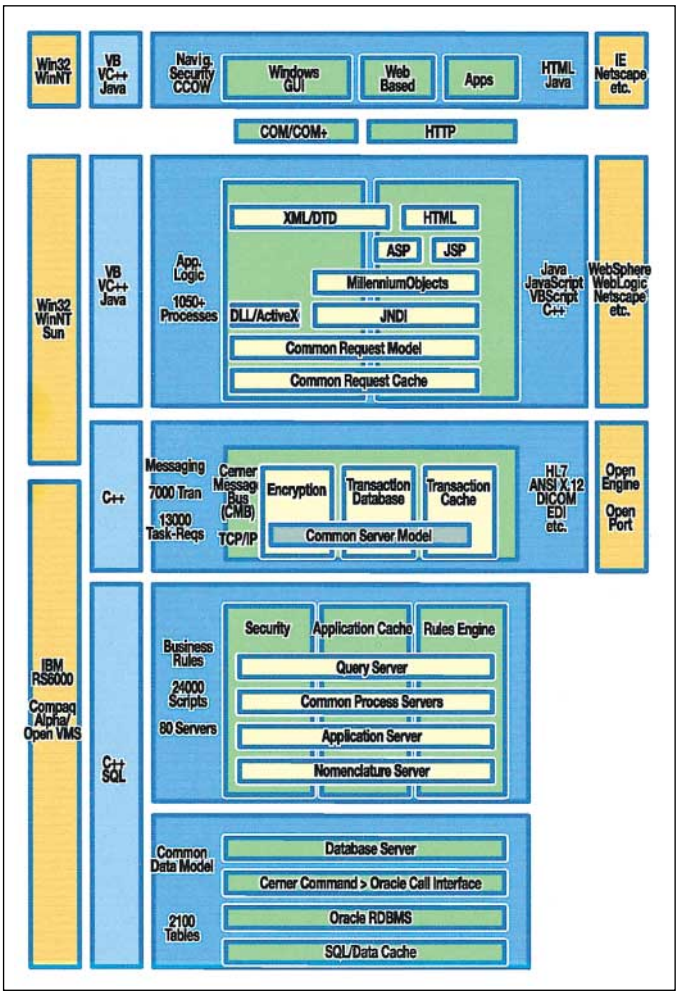

Fig. 2
Cerner Millenium architecture. The graphic displays the different layers and implementation techniques of the Cerner Millennium architecture as well as the underlying operating system platforms.

6.2 Implementation Strategy

Prototyping proved more successful than the classic project path (the so-called "V-model"). Early presentations of raw software functionality helped to drive the implementation to meet the expectations of the responsible end user. Every department was regarded as a small, independent

project with specific requirements necessitating some modifications. Consistent with tradition in European university hospitals, the clinical departments maintained their autonomy, strongly influencing decisions as to which modules of a CIS would be implemented. This culture demanded that software be of high quality, provide flexibility, and deliver clear benefits for the physicians.

The tight project schedule required flexibility on the part of the IT-project teams as well. The limited availability of clinicians made scheduling planning meetings difficult, yet all of the design meetings had to be coordinated with the care processes for which the physicians were responsible.

End user training was organized to foster acceptance at the point of use and provide positive marketing for the system. For the majority of end users, training was their first contact with the system and with members of the project teams. As professionals, the users were given the opportunity to book training via Intranet or a hotline. To date, the training given has received positive evaluations for organization and delivery.

However, initial end user training was not sufficient to ensure a successful implementation. More was required. The complexity of a comprehensive system made added support during the first days after "go live" critically necessary.

6.3 Future Initiatives

As of this writing, implementation of Cerner Millennium software continues at UHI. Despite the recognition that certain functionalities, such as order management, will take years to implement, TILAK remains convinced that Millennium can indeed provide the basis for an enterprise-wide EPR.

Systematic studies of end user acceptance are in process and will be reported in separate publications. At this point in the implementation, direct quantification of benefits remains difficult. Work in this area will continue, as will measurements such as those reported in this article.

7. Conclusions

To date, the introduction of Cerner Millennium at TILAK has achieved essential goals defined at the beginning of the project (see Table 2 for key data). It has also taught valuable lessons in how to encourage acceptance of such a system and ensure that it meets the necessary requirements in a European health care setting:

- Offer basic functionalities – free text documentation, standardized documentation, scheduling, and some parts of order entry – in a user friendly manner.
- Present information in a way that provides apparent advantages to the users at the onset.
- Stress how the investment benefits not only the quality and efficiency of care but also the quality of the work of the staff.
- Foster high levels of interaction between the vendor, the teams installing the system, and the users.

As a research oriented institution, the University Hospital of Innsbruck holds a vision of integrated health care (9) that demands very special functionalities. Accordingly, one very important decision criterion stipulates state-of-the-art tools integrated into the system. Cost pressures, especially the new data-based financing models, combine with demands for new medical technologies and more information at the point of care to drive the introduction of the EPR (11). Accordingly, the remainder of the implementation targets offering features such as decision support, structured documentation, access to knowledge bases for evidence-based medicine, implementation of guidelines, and data analysis tools (12, 13).

By bringing information technology closer to the point of care, these functionalities will impact workflow and professional roles for physicians, nurses, and other staff. Inevitably, this advanced phase of installation will thus require changes and pose or even demand organizational challenges. Consider, for example, the environment when mobile terminals become available and order entry and structured documentation are introduced into the enterprise. Physicians will have to do much more online documentation. Consider also the impact of features such as automated suggestions for prescriptions. Here information technology will lead to the transformation of the medical culture itself. Discussions will be intense and essential to experiencing the changes brought by the installation of the Cerner software. As was true in the earlier phases of the installation, acceptance at the point of use will be critical, necessitating careful attention to end user needs, training, and support.

Based on the experience to date, TILAK and the University Hospital of Innsbruck consider Millennium one of the most advanced integrated systems. Cerner's vision (14) will lead to further new functionalities within the next few years, improving efficiency, safety, and quality.

Implementing an American clinical information system in a European health care surrounding means also modification and in some areas an extension of functionalities benefiting both sides. The Cerner software e.g. contains a lot of content which is very advanced but cannot always be used without minor or major modifications. For example, the concepts for structured documentation are very sophisticated and useful for data analysis. It only works in English

Table 2 This table provides an overview of the key data of the CERNER Millennium implementation at TILAK.

Parameter
Clinical Departments at UHI
Registered Users
Concurrent Users at peak times
Installed PC Clients
Documents written in CERNER M
Radiology findings fed into the sy

and it will be a lot of work to make this highly interesting possibility available in other languages. Another interesting aspect will be the integration between the hospital and extramural health care providers or the implementation of modules for hospital financing based on special catalogues of diagnoses, procedures and using special groupers. It is a big challenge for both sides to learn from each other and to foster the development of clinical processes and standards.

What we have learned is that a system as we have described it will bring about a transformation of our health care delivery practices at TILAK. The need for carefully designed change management processes linked to both training and education of our entire organization , from the care giver to the administrator, is the key to realizing the goal we and our chosen vendor envisioned. We must overcome cultural and functional differences when it comes to installing an American designed system. Both parties will learn and have learned from each other in this process of adaptation.

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