European Journal of ePractice
A publication of epractice.eu
Meet > Share > Learn at www.epracticejournal.eu

Making the clinical process safe and efficient using RFID in healthcare

Elena Sini

Italian National Cancer Institute

Paolo Locatelli

Fondazione Politecnico di Milano

Nicola Restifo

Fondazione Politecnico di Milano

Keywords

blood transfusion, transfusion safety, RFID technology, bedside transfusion errors, Oncological Tissue Bank, surgical instruments, tracking, hospital management

The Fondazione Istituto Nazionale dei Tumori (the Italian National Cancer Institute) in Milan can be considered a forerunner in the usage of Radio Frequency Identification (RFID) in the European healthcare sector, as it is moving towards this technology in many clinical areas. The Istituto had a need for greater efficiency in the management of the transfusion process, as it had no information system for the detailed monitoring and control of the process; the transfusion service did not have instant access to all the necessary information and for some procedures operators only have access to hard-copy aids.

Using RFID the Istituto can now achieve a greater capacity for controlling and monitoring the transfusion system, with the aim of enhancing safety, transparency and quality. RFID tags are sticked on blood bags and patient wristbands. Staff is provided with RFID identification cards and PDAs (with an application developed by the project team) and thus enabled to register patients at their arrival, verify the patient-blood match and recognise at any time patients and transfusional units. Each event is automatically traced by the system and sent to the Transfusion Centre, providing an essential informative feedback which was not available before.

The extension of the system to the whole transfusion process (including e.g. the match of blood sample tubes, haemovigilance reporting and functionality enhancements) as well as its implementation to all the Istituto's wards and to pilot wards at Ospedale Niguarda (the most important hospital in Milan) has been founded by the Regional Administration of Lombardy. Moreover, the Istituto asked the project team (which includes also Fondazione Politecnico di Milano) to exploit the achieved experience in a new project about total traceability over time- and temperature-sensitive surgical specimens from the operating table to the Oncological Tissue Bank, as well as for tracking surgical instruments.

> "The application using RFID technology allows the interaction of two existing compartmentalised systems and supports operators involved in the transfusion process."

1 Introduction

This paper aims at presenting a case of excellence in the field of RFID applications in the Italian and European hospital sector regarding both methodology and project outputs.

At first, we will illustrate a brief overview on the state-of-the-art of RFID applications in the healthcare sector, underlining the value of an approach based on a systemic model of change management: this is the scenario in which the case study we are going to describe has to be contextualized. The Istituto Nazionale dei Tumori di Milano (the Italian National Cancer Institute in Milan) has developed an ICT strategy in which RFID technologies play an important role. This paper will mainly focus on the first project being set up for granting safer transfusion in the Institute, describing the initial process configuration, critical issues addressed, the first pilot intervention, the achieved results and following developments. Afterwards, we will also describe some other key projects in the clinical area, underlining how they are bound by a coherent strategy and a shared approach to technological and organizational evolution.

2 The importance of RFID technology in the healthcare sector

A year-by-year increasing number of new projects reveals that the Italian healthcare sector is more and more interested in RFID technology[1]. For all, the application of this technology is still at an experimental stage, thus counting to grow both in new pilot and executive systems. General benefits ascribed to RFID can be summarized as follows:

- Speed of data access and multiple item identification without need to have the tags on the line of sight;
- Safety of electronic matches, item identification and data transfer;
- Automation of some process activities and information flows;
- Chance to implement workflow management rules, bounding health workers to follow the implemented procedures;
- Remote item/people tracking and real time process monitoring.

These issues usually lead to overall benefits on terms of process efficiency and effectiveness.

The most important application areas in the healthcare sector are:

- Identification and geolocation of people or objects;
- Operations support;
- Logistics.

As the School of Management of the Politecnico di Milano Technical University states (Osservatorio RFID, 2005; 2006; 2007), RFID technology reveals a potentially powerful means, as it can be used to ensure fast and unambiguous identification of patients and asset location within the hospital complex. Applications to *people* usually implement disposable passive tags embedded in the employees' identification cards or patient wristbands, usually activated and assigned during hospital admission. Hospital staff can therefore use its cards to log in to the hospital information system, access restricted areas and digitally sign documents. Patient wristbands can be checked during the practitioner's visit or before undergoing a sampling or an operation (like dialysis, surgery, a transfusion and so on). The tag may store data ranging from the single pointer to a record in the hospital information system database, to a complete dataset about the patient (personal data, patient

[1] For general information on RFID technology, see: http://en.wikipedia.org/wiki/RFID; for detailed information on RFID technology, see: Auto-ID Center, Massachusetts Institute of Technology, http://www.autoidlabs.org and The UK Institution of Engineering and Technology, http://www.theiet.org.

record identification number, blood type, allergies, ongoing therapy, etc). A second feature of RFID technology is the implementation of active tags in a WiFi environment: this enables a more effective patient location and real time monitoring of patient flows and of their progress in the care process (particularly in the diagnostic phase or in the First Aid station), thus also acquiring important data for process and layout optimization. As a matter of fact, RFID and geolocation tools are important means enabling new advanced applications and tools for coordinating wards, optimising operational costs and reducing patient waiting time. The same technology can be used also for *asset* location and management of maintenance operations: e.g. portable devices (defibrillators, monitors, pulmotors, etc), surgical instruments, surgical samples and valuable items at high risk of loss or theft. Similar remarks can be made about patient record identification: folders often don't follow the patient during his transfers through the wards and there are often problems related to documents retrieval. Also beds and perambulators are often scattered along the buildings: item tracing reduces wasted searching time and can lead to speedy intervention. Other systems, coming directly from operations support systems in the machinery sector, are for example: sample tagging for automatic processing in the laboratory, item tagging for blood bank or pharma cabinets control both in the replenishment and in the picking phase, systems for automated issue of medicine doses. A third high potential cluster regards applications implementing combined identification of *people and items*, thus enabling a patient-to-object crossmatch. These applications can be successfully implemented for example to control drug administration, in the operating theatre and in the transfusion area.

Annual surveys of implementations in Italy issued by the Osservatorio RFID (2005; 2006; 2007) outline: a small but growing series of applications characterized by a reduced number of functionalities (compared to the potential range of achievable support) and a narrow process coverage, with low pervasiveness in process activities. In fact, although operations support is considered a quite well-established application area in the industry, in the Italian healthcare sector it is still at an experimental stage of development. This is quite peculiar, if we consider that the healthcare sector is mainly demanding quite complex functionalities, including sensoring, active tracking, high safety standards and multiple combined person-item crossmatches. In general, setting aside specific ambits, we can say RFID technology shows three stages of application, which are incremental steps on a scale about process reengineering: the higher the depth of the change brought out on activities, the higher the potential exploited and the organizational impact (see Table 1). An integrated and systemic approach to technological and organizational evolution like the Business Process Reengineering Framework – B.P.R. (Davenport,1993; Ernst & Young, 1997) is essential to fully realize this potential, because it helps to identify all possible areas of impact on processes and on the organization, so to enable an all-round process and management following a new viewpoint.

Time Frame	Area of intervention	Examples of applications	Target	Range of action
Now	Intervention on support processes: near existing technologies	Patient identification EPR access Ward safety Access control	Enhancement in current activities, with low organizational impact	Narrow
Tomorrow	Intervention on single core processes ("stand alone" solution)	Error reduction (patient/drug/meals/etc) Blood bags tracking Internal logistics (e.g. drugs) Patient monitoring	Efficiency / Effectiveness / Safety of single process	BPR project on a single process

Future	Whole organization	Clinical process control and workflow management Extensive tracking in logistics Safety systems More effective management control	Overall efficiency and effectiveness	Extended BPR project covering the whole organization

Table 1: *Current and future opportunities for RFID implementations in the Italian healthcare sector.*

3 Integrated RFID strategy at the National Cancer Institute in Milan

Founded in 1925, the Fondazione IRCCS Istituto Nazionale dei Tumori is recognised as a Scientific Research and Treatment Institution (IRCCS) and was recently awarded Foundation status. This means the organization has achieved excellence nationally and internationally in the field of pre-clinical and clinical oncology. More than 350 research projects are currently under way, many of these being undertaken with the most prestigious international institutions, in addition to various collaborative projects with universities and health organizations. About 2,200 patients pass through the Istituto every day; there are approximately 14,000 ordinary admissions (39% relating to patients from outside Lombardy) and about 12,000 Day Hospital admissions. There is an annual average of 900,000 outpatient treatments and more than 15,000 surgical treatments (including 28 liver transplants). The number of accredited beds is 418. The Foundation's researchers publish about 300 scientific papers each year, mostly in international scientific journals. The Foundation also manages the Lombardy Cancer Network (ROL).

The Istituto can be considered a forerunner in the usage of RFID in the European hospital sector, as it is moving towards RFID technology in many clinical areas, aiming at implementing a series of applications than can be considered quite advanced in the framework described before.

As a matter of fact, these activities are an integral part of the CIO's strategy, which focuses on the development of a common infrastructure to enable the spread of IT tools to support core clinical processes in the Institute. The guidelines are, for example: adoption of a coherent and integrated approach to technological and organizational evolution, implementation of a wireless LAN, use of standard programming frameworks and to spread ergonomic devices (like PDA) in the wards. .

Focusing on RFID technology, current key projects address:

a) General patient identification,
b) Safety and traceability of blood transfusions,
c) Tissue bank operations,
d) Management of surgical instruments.

4 Safe transfusions and total blood traceability in the ward thanks to RFID technology

4.1 Transfusion safety

It has been recognized that blood transfusion errors remain under-reported, owing to a lack of awareness about transfusion-related adverse events among hospital staff and inadequate feedback system in most of the transfusion centres (Sharma et al., 2001). In spite of this, the medical community acknowledges that the main risk of transfusion adverse events is mainly process-related

rather then infectious. As stated by the scientific community, infective risk related to transfusion is sinking more and more as a result of ever increasing past expenditure on blood safety, while less attention has been paid to improving the safety of the transfusion chain within hospitals (Murphy et al., 2001; Bush, 2003; Murphy et al., 2004; Stainsby, 2005).

Based on reports issued by the authoritative Serious Hazards of Transfusion (SHOT-UK Scheme) between 1996 and 2003, the risk of an error occurring during transfusion of a blood component is estimated 1:16.500, an ABO incompatible transfusion at 1:100.000 and the risk as a result of an "incorrect blood component transfused" (ICBT) is around 1:1.500.000 (Stainsby et al., 2004).

The chart in Figure 1 shows the distribution of adverse events related to transfusion as reported from Shot-UK Scheme in 2005. There is a number of critical stages in the transfusion chain, starting with the decision to transfuse, prescription and request, patient sampling, pre-transfusion testing and finally the collection of the component from the blood refrigerator and administration to the patient, consistently the most common error in successive SHOT reports.

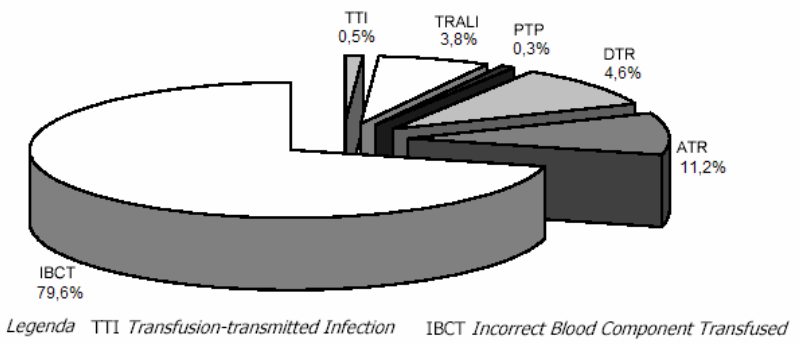

***Figure 1**: Adverse events related to transfusion as reported from Shot-UK Scheme in 2005. (Source: The Serious Hazards of Transfusion Steering Group, 2005*

4.2 Background and original process configuration

The Institute's Transfusion Centre (SIMT) belongs to the Department of Experimental Oncology and provides blood bags and other services to all other wards. The staff dealing with the transfusion process consists of six laboratory technicians and six biologists/physicians.

Each transfusion uses a bag containing the blood component required by a specific patient, and is prepared according to a precise procedure. A label is affixed to the bag, showing all the necessary information, and then the laboratory technician does a final check and consigns it to an operator who takes it to the destination ward. On arrival, a physician supervises the transfusion, as it is carried out by a qualified nurse, and records on the patient's notes the transfusion. The basic architecture consists of three information systems: the analytical laboratory (DN-Lab), the central clinical and health system (legacy), and the application which controls all the regional transfusion organizations (EmoNet). However, the three systems do not operate in an integrated way. There is also a lack of detailed reporting on the final part of the process: for example the Transfusion Centre has no information about the status of the units delivered (if transfused, if stored in the ward, if wrongly issued and so on). Figure 2 shows a diagram of the transfusion process in the TMO ward of the Istituto and indicates the main critical points emerged during the process analysis.

These critical points can be summarized in three key topics:

- Lacks in process controlling capability due to poor information record and communication within actors belonging to different departments;
- Absence of fast, safe and unambiguous identification system for patients, sample tubes and blood bags;
- Paperwork and manual activities scarcely supported by existing IT systems.

Thus, the Istituto had a need for greater efficiency in the management of the transfusion process, as it had no information system for the detailed monitoring and control of the process. The doctors in the transfusion service did not have instant access to all the necessary information and for some procedures operators only have access to hard-copy aids.

The answer to the problems was the development of a monitoring and control system for the procedure, all the way from the selection of a bag to the completion of a transfusion, ensuring the traceability of the transfusion process.

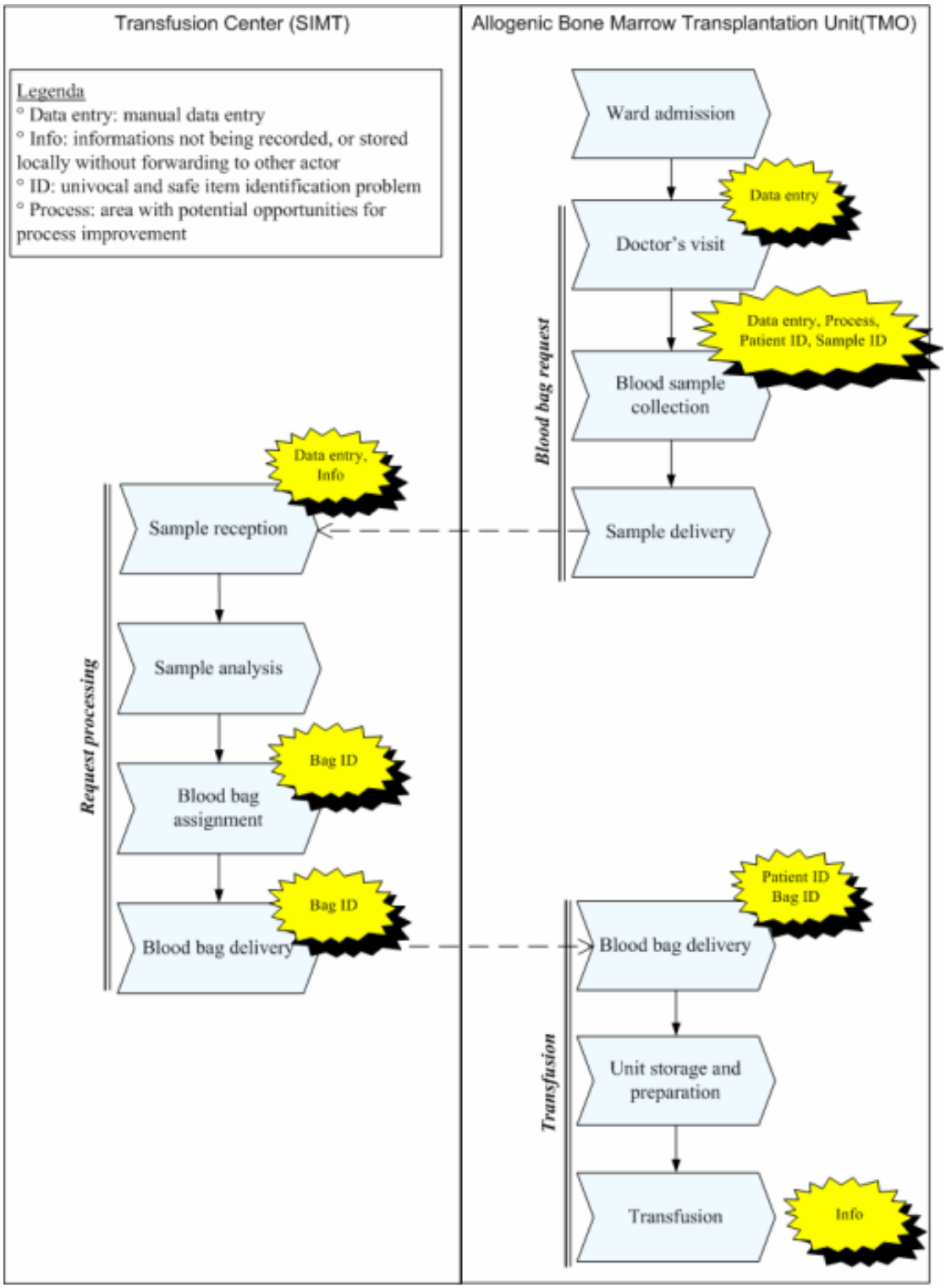

Figure 2: *The transfusion process with critical points in highlight*

4.3 The pilot project

From October 2005 to December 2006 the management of the Istituto set the objective of reengineering the transfusion processes, using Radio Frequency Identification (RFID) to provide traceability in the interests of safety and efficiency. So, a pilot project has been implemented in the

Allogenic Bone Marrow Transplantation Unit (TMO), a ward belonging to the Department of Oncology since 2001, which represents one of the excellence Departments of the Istituto. This excellence is true also for the blood transfusion process: in fact the compliance with recommended guidelines enables the ward to return only 2% of unused blood bags every year, against an average of the Istituto of 11%. The ward uses 9,1% of the total number of transfusion units (1.177 out of 12.985 throughout the entire Istituto), but they account for 26% of total value of managed blood bags: i.e. the average value of blood units they use is higher than the average of other departments; therefore the potential impact in terms of higher efficiency and effectiveness is deeper.

The project team started by carrying out a major analytical operation based on interviews with users in various departments and tracing flows, after which an ad hoc solution was outlined with the aid of the partners Fondazione Politecnico di Milano and HP. Testing started soon after. The application using RFID technology allows the interaction of two existing compartmentalised systems and supports operators involved in the transfusion process. Working with the Fondazione Politecnico and the Istituto's ICT staff, the HP engineers have identified the most suitable materials (wristbands, tags, labels, printers), aiming to achieve technological integration and develop an interface as simple and intuitive as possible.

When patients are admitted, their names are checked against the data in the registers of the central information system by using handheld terminals, fitted with RFID antennae. The nurse then gives the patient a wristband and initialises the bedside tag, so that the patient can be safely identified (no batch tagging procedure is allowed to avoid swaps of patients). Physicians and operators then use PDAs to transmit and acquire information, by means of RFID labels affixed to each bag by the Transfusion Centre as it is assigned. The nurses receiving each bag use their PDAs to record the time of arrival and read the patient's wristband to match the data, thus ensuring that the correct transfusion bag has been received. The transfusion operator also uses the PDA to identify himself by means of a badge, and then continues with the procedure, recording both the starting time and the finishing time of the process, also having the opportunity to enter a set of other clinical notes relating to the event. The new RFID system makes transfusions absolutely safe: if there is a conflict between the data read from the specimen or from the bag and the patient's wristband, the system immediately issues a visual and acoustic alarm and halts the application (thus covering two phases which are proven to be the most common source of error). Finally, when the patient is discharged, the staff is responsible for deleting information embedded in the disposed wristbands.

The developed system consists of four main elements, as represented in Figure 3:

a) The transfusion management application running on PDAs;

b) The newly developed application, which allows the staff to perform all operations described above (patient check-in, patient identification, self-identification, blood bag identification, bedside crossmatch) supporting critical steps of the transfusion procedure;

c) TMO ward client application to download to the PDA the admitted patient's data and to download from the PDA the data on performed transfusions;

d) Transfusion Center client integrated with EmoNet system for seamless print of standard and RFID labels simultaneously on the two printers;

e) HTTP daemon filling the XML interchange file on the ward client and managing EmoNet's database seamless alignment via the internal communication network.

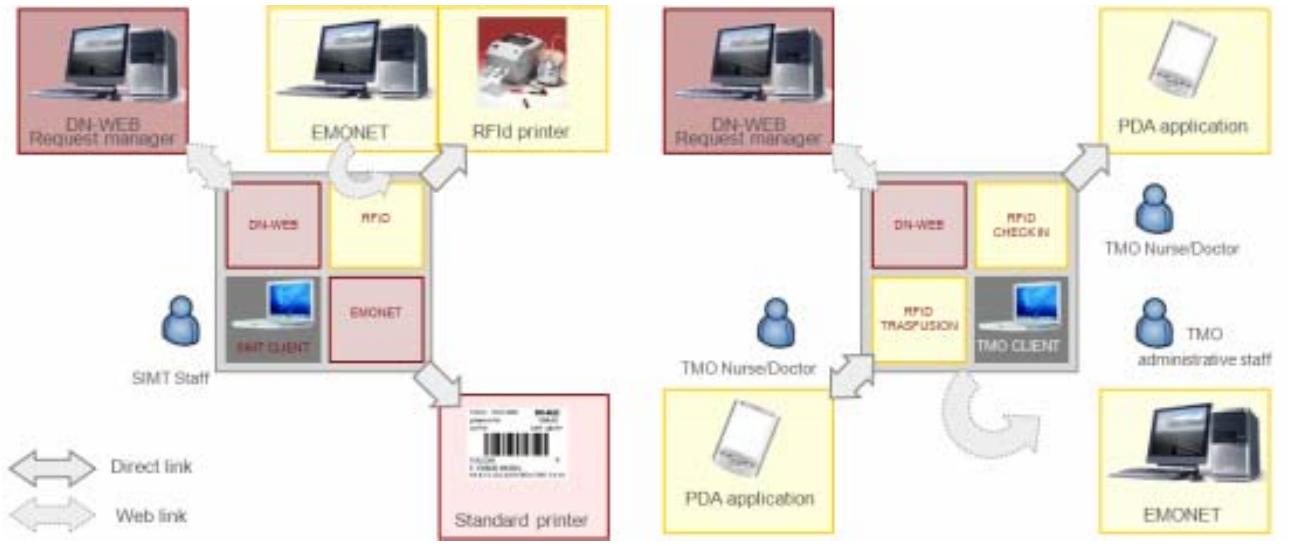

Figure 3: *Schema of the system issued to INT in its pilot configuration*

Thanks to this architecture, staff in the Transfusion Centre is now able to receive electronically information from the ward about the transfusions performed and to monitor the status of delivered blood bags. While the staff badge contains only a personal identification number and the operator's name, tags affixed to patient's wristbands and to blood bags store more important information. The first contain the health record number, the patient's name and birth date, his blood group and phenotype. This data is used to crossmatch the blood bag to be transfused, with a tag including: the unique bag identification code, type of blood component, blood group and phenotype, recipient's name and birth date.

The transfusion management application tracks each event regarding the use of the PDAs and stores on the device the data read from the tags and manual data entries performed by staff (near-miss events, messages from the physicians or nurses, reasons for misuse..). This information is subsequently forwarded to the ward application in order to generate the interchange file for the alignment of the Emonet system. This means that, while at first the Transfusion Centre had no feedback about the status of the delivered units, now a continuous information flow has been established starting from the patients' beds, feeding the transfusion information system with reliable and timely data.

In accordance with best practices in management theory, the project team has established a complete KPI (Key Performance Indicators) panel for process monitoring and evaluation. The schema in Figure 4 shows the map used to evaluate returns of the project, grouped in material and immaterial benefits.

It is important to underline that, being a case of a pilot study, it has little meaning searching for margins and efficiency returns, goals that will be surely achieved in the next development phases.

The partner's skills and the highly cooperative attitude of physicians and nurses were important factors in the achievement of outstanding results in the provision of a service, as stated by the KPI process monitoring panel audit.

In brief, business benefits can be summarized as follows:

- Total traceability of the transfusion process;
- Rationalisation and improved efficiency of the transfusion process;
- Improved safety of patients and medical staff involved in the transfusion process;
- Non-invasive technology for patients, with increased and improved capacity for intervention where patients are unable to interact with the medical staff;
- Enhanced process awareness by staff;
- Cost reduction by enabling blood bag monitoring and better control on blood consumption in the ward;
- Enhanced capability of process monitoring and controlling, through a continuous flow of information between the departments involved.

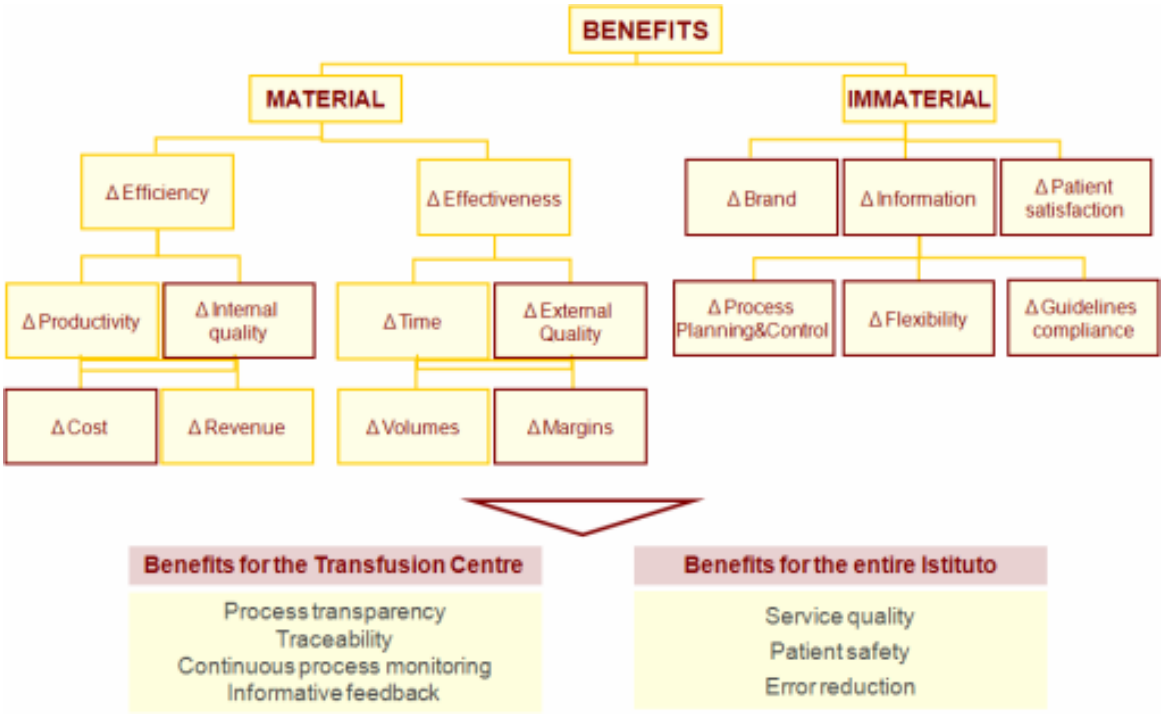

Figure 4: *Key performance indicators map. Highlighted (in dark frames) the benefits achieved (Adapted from: Osservatorio RFID, 2006)*

Back to the themes of safety and quality assurance, team members have performed a high-level analysis to estimate the impact of the new application in terms of risk management, based on the guidelines of the Health care Failure Mode and Effect Analysis (DeRosier et al, 2002; Trucco, 2000). Being a pilot project, this assessment regarded an overall investigation of potential sources of errors in the original process configuration (to be addressed by specific features in the application to be developed) as well as in the reengineered process, to evaluate the effectiveness of the intervention and possible critical points connected to the new solution. During the system roll-out, some team resources were dedicated to safeguard ward operations, solving contingent problems and also revising readily some functionalities to meet clinical needs. An extensive risk analysis will be performed in subsequent project steps described in the next paragraph.

Thanks to the RFID solution, the Istituto has been able to introduce a further safety mechanism in the transfusion procedure: the reliable identification and crossmatch between patients and blood bags,

enabling process control as well as the identification of potential weak links in the service chain. This is particularly true if we consider that the developed application implements a workflow management engine to guide operators through the different steps of the transfusion procedure in form of a 'wizard'. Thus so-called 'coverage errors' as well as invalid data entries can be effectively avoided.

Furthermore, using wristbands, nurses and physicians can achieve a fast and unique identification at any time, regardless of the patient's condition, allowing them to intervene with treatment at the correct time.

With the RFID system, the staff now operates in a highly integrated and advanced IT environment, providing better management of the transfusion process, based on a high degree of control of the process itself and the facilitation of employees' work.

The results of the pilot project have been surprising also in terms of feedbacks received by staff: managers are well impressed about the quality and quantity of information, which makes the processes efficient and well supervised, guaranteeing a high quality of service to patients.

Also medical staff and nurses feel quite comfortable with the system and claim for its availability: the ward head nurse is a very proactive advocate of innovative ICT solutions and acts as a focal point for the ICT department. The System Usage Rate is a particularly meaningful indicator among those recorded: it indicates in form of percentage the number of RFID transfusions compared to the number of total transfusions carried out in the ward. As shown in Figure 5, from the beginning of the test phase, a continuous improvement of the usage rate has been registered. Mean usage rate in September – October – November 2006 is 83% but from the fourth month of testing the mean usage rate has shown above 90%. If we purify these data from incidental events occurred during testing phase (system unavailable, patients transferred to detached ward areas and so on) the mean usage rate indicator points to 98,4%.

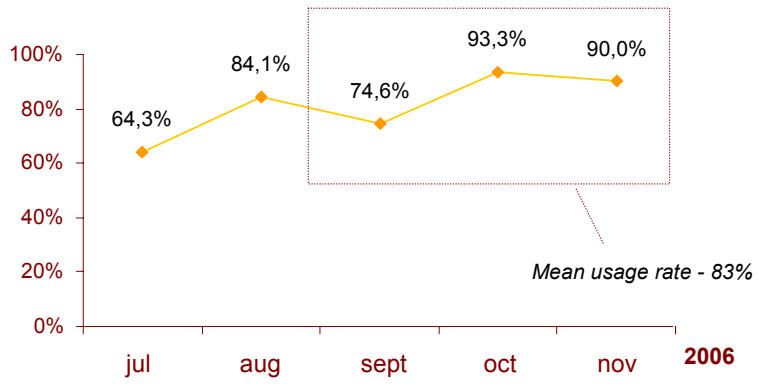

Figure 5: *Overall system usage rate indicator (data referring to Sept-Oct-Nov 2006 trials).*

As Figure 6 shows, high system usage rate was experienced in both wards (TMO and Transfusion Centre). This points out to:

- A user-friendly application,
- A well engineered interface easy to use and with step-by-step operational guide,
- A successful medical staff training,
- An effective project team support to medical staff,
- Proactive staff attitude.

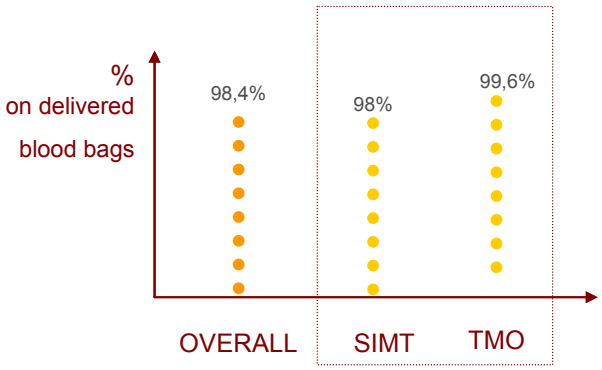

Figure 6: *System usage rate experienced in the two wards (data referring to Sept-Oct-Nov 2006 trials)*

Estimates were made to better represent the results in terms of informative feedback to Administrative staff and Transfusion Center: in one of these we see a projection of the performance achieved with the help of the new transfusion application in the TMO ward on overall Istituto's transfusion volumes in September, October and November 2006. The aim is to see on how many units the Istituto would have received an informative feedback (and so how many units the Istituto would have under control) if the application was extended to all departments.

Data refer:

- To units delivered by Transfusion Centre in September, October and November 2006 (2.405 units delivered);
- To the estimated return rate of non-transfused units registered in TMO ward in the test period (13,2%);
- To the system usage rate registered in TMO unit (98,4%);
- To excellence quality standards followed by TMO Unit staff.

Figure 7 shows an abstract of this analysis' results: on 2.405 units delivered (estimated value: over 470.000 €), the Istituto would have been able to have an informative feedback (and thus keeping under control) on 2.371 units (98,4%). The Istituto would actually have become no informative feedback on 1,4 % of the sent units, this caused by incidental events or non-use of the systems by nurses as it happened in the TMO ward. It is important to notice that the value of this "little" 34 units is over 6.700 €!

In conclusion, the project enabled to achieve two aims: safety for patients and detailed information for doctors and operators in a context of advanced knowledge management.

Figure 7*: Pilot's results projection on overall Istituto's activities (data referring to September – October – November 2006 Istituto transfusion activities)*

4.4 The new project for extended transfusion traceability

The excellent results from the pilot project culminated in the IDC EMEA 2007 Award for ICT Innovation and in a selection in a European Call For Ideas for official presentation at the RFID Conference & Exhibition "Towards a European Policy on RFID" in Lisbon promoted in November 2007 by the Portuguese EU Presidency. This project has also been invited in 2007 for presentation both at the ID World International Congress 2007 in Milan (an annual event about RFID, biometrics and smart card technologies) and at the Risk Management in Healthcare Forum of Arezzo (an annual event organized by the Italian Ministry of Health, the National Institute of Health and Gutenberg, in partnership with Regione Toscana).

Thus, the Istituto will receive a new round of funding from the Regional Government of Lombardy for a 2-year initiative to extend the solution to the entire cycle of transfusion and to collaborate with other hospitals in Milan (like, for example, the Niguarda Hospital[2]), which the regional government is pushing to adopt the same model.

As a matter of fact, the new phase of the project will aim at (see Figure 8):

- Mapping transfusion processes in all involved Institutions and developing a high-level parametrical application model of high significance, that can be customized through parametrization;
- Reengineering the RFID pilot application, including new functions (like tracing of blood sample tubes in order to close the entire loop of transfusion), improving system integration with the laboratory application (DN-Lab) and the regional blood bank network information system (EmoNet), implementing a WiFi network to enable real-time synchronization of data between servers and handheld devices;
- Validate the achieved results extending the reengineered RFID system to the entire Transfusion Department of the Istituto (i.e. to apply tags to all 13,000 blood bags dispatched every year) and also to selected wards of other partner hospitals in the Region;
- Extend the RFID platform infrastructure to other processes using the same approach (see next paragraph for some examples on new projects which are already started);
- Extensive evaluation of the impact of project activities in terms of Clinical Risk Management, deepening the preliminary analysis performed during the pilot project. This will be done using an extended version of the Health care Failure Mode and Effect Analysis – the HFMEA model (DeRosier et al, 2002; Trucco, 2000). The HFMEA model allows toquantify the risk profile associated to the analyzed process, identifying and valuing the possible criticalities and failure modes that feature it, considering both clinical issues and technology-related risks. In fact, this innovative model allows to make comparisons between different configurations of the activity flows or with any comparable process, considering quantitatively at the same time also the probable efficacy of the risk barriers introduced by the employment of ICT systems and the risk introduced when implementing such technologies.

A further project has been submitted to the Italian Ministry of Health for further funding aiming at:

- Addressing critical issues related to the use of RFID/WiFi systems in critical environments (like e.g. intensive care units, the operatory theatre, outpatients and domiciliary care);
- Developing and implementing a tool for supporting new regulations on transfusion traceability and haemovigilance (see Italian Legislative decree 09/11/2007 n.207, actuating EEC Directive 2005/61/CE and 2002/98/CE), thus experimenting a new instrument for adverse events reporting based on digitalization of clinical documentation related to transfusions (transfusion

[2] The Ospedale Maggiore Niguarda “Ca’Granda” is the leading public hospital in Milan since 1939. It is national reference hospital for emergency events and the only regional point of care qualified to perform any kind of tissue and organ transplant. The Hospital has 1.540 doctors and 740 nurses, 54.000 yearly admissions (both ordinary and Day Hospital) and 3 millions First Aid Station treatments.

request, LIS (Laboratory Information System) report on sample analysis, haemovigilance forms,..); implementing also digital signature (CRS-SISS regional system) for transfusion validation.

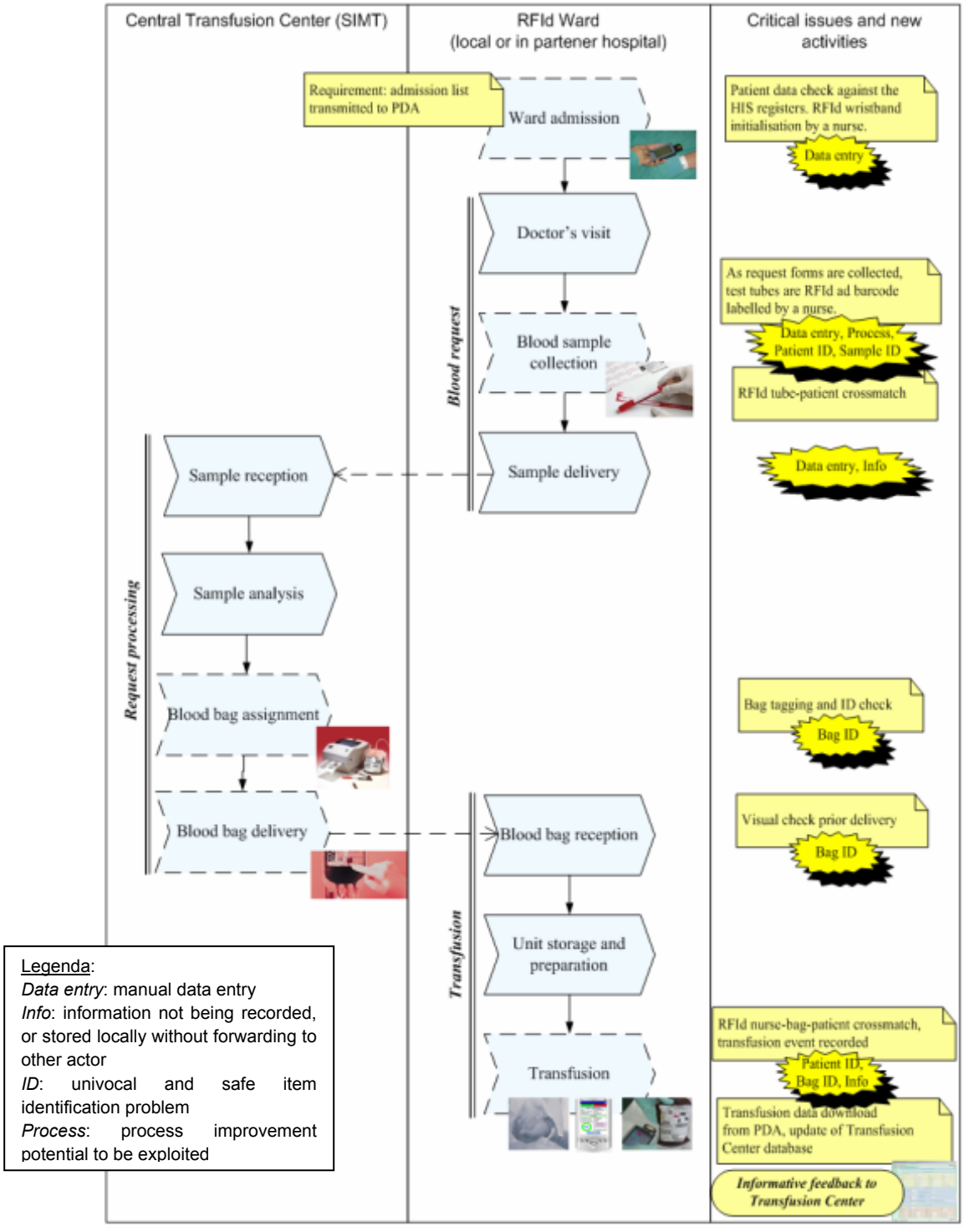

Figure 8: *Diagram of the transfusion process being reengineered, with planned actions and critical issues being solved.*

5 The Tissue Bank project: active monitoring through RFID

A biobank is a collection of biologic specimens stored for later analysis under conditions which permit efficient retrieval and optimal stability of the sample. Its main goals are to store and process samples collected from ongoing studies in a way that maximizes the amount of information obtained from each sample, makes possible future analysis for currently unknown biomarkers and minimizes research costs for future studies.

Department of Experimental Oncology and Laboratories collaborates with the Department of Pathology in the Tissue Bank of Istituto Nazionale Tumori, a project of the Scientific Direction dedicated to the collection and distribution of samples of neoplastic, preneoplastic and normal tissues from human subjects. The Tissue Bank stores the specimens coming from the Department of Pathology and makes them available for the research projects active in the Istituto. Since the quality of research outcome strongly depends on specimen quality, it is of primary relevance to trace and monitor the path from patient sampling in the operating theatre to deep-freeze storage in the biobank, where cells ischemia due to devascularisation is stopped. At the present time quality control over the process is hard to perform, because many activities need IT support and organizational enhancements, for example to monitor process lead time, to enable information exchange between the involved departments, to significantly reduce paperwork and related current communication problems. Some critical issue are: the absence of a process owner and process orientation of the involved resources; the absence of integration between the surgery legacy IT system, the Department of Pathology system and tissue bank repository; the lack of a unique accessible digital repository supporting efficient biobank operations and research activities.

Answering these and other needs, the new project on RFID technology focuses on:

- The exact identification of specimen,
- Tracing the process and transport lead times,
- Monitoring the specimen condition by tracing via active/semiactive sensors environmental conditions,
- Implementing reviewed high quality standards for processing and storing biobank samples, also investing on new hardware;
- Constituting a single data base where to collect all the relevant information to support diagnosis and scientific research.

Project activities started in fall 2007 and will end in 2009.

6 Tracking surgical instruments in the operating theatre

The management of surgical instruments is a major problem for most healthcare facilities. In addition to the loss issue (ranging from simply lost or misplaced instruments to outright theft), there has been a need to track both the instruments themselves and the entire process associated with them, aiming at optimizing instrument inventory and utilization and patient safety. The surgical instrument cycle includes procurement, assembly, packaging, sterilization, storage, distribution, utilization in the surgical suite and other clinical settings, and the decontamination process. Most of the systems available today have the ability to track instrument sets throughout the entire processing cycle including the sterilization cycle, a particularly critical issue in the healthcare environment.

The Istituto Nazionale Tumori is now evaluating the extension of the RFID platform to this core process, starting with internal management of surgical kits and single item checks before and after surgical operations. The current system is based on barcode and manual handwritten labels used only to report kit-patient assignments on the patient record when they are used during surgery. No other support is provided to the staff to check items such as missing or damaged instruments before

starting surgery, to monitor the presence of instruments left in the room from previous operations, to support counting of all items before and after a surgery and so on.

Thanks to the tag's memory, important data could be stored in the instrument and could be modified or updated according to the evolution of the instrument's journey, for example: part number; GS1, HIBC or proprietary code; last maintenance or repair date; last sterilization date and so on.

Each instrument becomes a unique part, thanks to its codification and the reliability and longevity of tags. In this field, RFID technology offers many advantages: flexibility and fast reading, reliable and durable identification of instruments, instrument identification possible even through packaging, identification of medical assets even if the tag is wet or dirty (blood, liquid,...), facilitated follow up of instrument maintenance or repair.

7 Conclusions

Potential benefits of RFID technology in the healthcare sector are well known especially in terms of safety and efficiency on day-by-day operations (e.g. internal logistics, transfusion process, etc). Nevertheless, to exploit this potential an integrated and systemic approach to technological and organizational evolution is essential, as always in case of process innovation connected to Information and Communication Technology.

The Istituto Nazionale dei Tumori in Milan can be considered a forerunner in the usage of RFID in the European hospital sector, as it is moving towards RFID technology in many clinical areas, aiming at implementing a series of applications than can be considered quite advanced in the framework described. Focusing on RFID technology, current key projects address:

1. General patient identification,
2. Safety and traceability of blood transfusions,
3. Tissue bank operations,
4. Management of surgical instruments.

Measurable and sustainable results, thanks to the innovative formula of the projects, are:

1. The need to reconcile a high degree of safety with a technology that is non-invasive neither for patients nor for staff, and which is also easy to deal with, because it will be used by all the personnel involved;
2. To support the information flow all over processes, creating a link between applications which were completely non communicating and enabling process control;
3. The change management activities and the user-friendliness of the applications succeed in rising great user interest and high usage rates;
4. The initial experimental use of RFID technology with a primary focus on traceability, process safety, compliance with procedures and immaterial benefits will now be deepened with actions targeted at other key elements like efficiency and cost performance improvement;
5. The use in the Italian Healthcare sector of new technology focusing on the enabling role of Information Technology on process governance instead on the diagnostic aspects of technology (machinery);
6. The challenge of developing a comprehensive application standard model for process management and operations running, which can be diffused at a regional scale;
7. The developed common RFID platform is an integral part of the existing IT application portfolio, thus integrated.

References

Bush (2003). Current and emerging infectious risks of blood transfusion. Journal of the American Medical Association, 289 (8), 959-962.

Davenport, T.H. (1993). Process Innovation. Reengineering Work through Information Technology. Boston: Harvard Business School Press.

DeRosier, J. et Stalhandske, E. et Bagian, J. et Nudell, T. (2002) Using Health care Failure Mode and Effect Analysis. Journal on Quality Improvement, May 2002.

Ernst & Young Consultants (1997). Innovazione dei processi. Riprogettare il lavoro attraverso l'Information Technology. Milano: Franco Angeli.

Murphy, M.F. et Kay, J.D.S. (2004). Patient identification: problems and potential solutions. Vox Sanguinis, 87(Suppl.2), S197-S202.

Murphy, M.F et Staves, J. (2001). Improving the safety of blood transfusion by re-engineering the hospital transfusion process with patient ID systems (John Radcliffe Hospital of Oxford), retrieved July 2006 from http://www.olympusamerica.com/pss_section/MM_Blood_Trans_Presentation/player.html

Osservatorio RFID - School of Management of the Politecnico di Milano (2005). RFID tra presente e futuro, I risultati 2005 dell'Osservatorio RFID. Milano: Politecnico di Milano, Dipartimento di Ingegneria Gestionale, retrieved January 15, 2008 from www.osservatori.net.

Osservatorio RFID - School of Management of the Politecnico di Milano, (2006). RFID alla prova dei fatti, I risultati 2006 dell'Osservatorio RFID. Milano: Politecnico di Milano, Dipartimento di Ingegneria Gestionale, retrieved January 15, 2008 from www.osservatori.net.

Osservatorio RFID - School of Management of the Politecnico di Milano (2007). RFID alla ricerca del valore, I risultati 2007 dell'Osservatorio RFID. Milano: Politecnico di Milano, Dipartimento di Ingegneria Gestionale, retrieved January 15, 2008 from www.osservatori.net.

Reason, J. (2000). Human errors: models and management. Cambridge: Cambridge University Press.

Sharma, R.R. et Kumar, S. et Agnihotri, S.K. (2001). Source of preventable errors related to transfusion. Vox Sanguinis, 81, 37-41.

Stainsby, D. et Russell, J. et Cohen, H. et Lilleyman, J. (2005). Reducing adverse events in blood transfusion. British journal of Haematology, 131, 8-12.

Stainsby, D. et Williamson, L. (2004). Six Years of shot reporting - its influence on UK blood safety 1996-2002, Transfusion and Apheresis Science, 31, 123-131.

The Serious Hazards of Transfusion Steering Group (2005), Annual report 2005 - Serious hazards of transfusion scheme, Manchester: Royal College of Pathologists, retrieved (retrieved January 15, 2008 from www.shotuk.org.

Trucco, P. (2004). Strumenti per l'analisi ed il miglioramento della sicurezza del paziente nei processi di cura. Indagine sperimentale sugli effetti in termini di qualità e riduzione dei costi sanitari. Rapporto finale della ricerca. Cod. IReR 2004B037. Regione Lombardia: IReR Regione Lombardia.

Authors

Elena Sini
CIO
Fondazione IRCCS Istituto Nazionale dei Tumori (Italian National Cancer Institute)
http://www.epractice.eu/people/12813/

Paolo Locatelli
Project manager
Fondazione Politecnico di Milano
http://www.epractice.eu/people/locatelli/

Nicola Restifo
Junior Analyst in support to the Area Manager
Fondazione Politecnico di Milano
http://www.epractice.eu/people/nrestifo/

The European Journal of ePractice is a digital publication on eTransformation by ePractice.eu, a portal created by the European Commission to promote the sharing of good practices in eGovernment, eHealth and eInclusion.

Edited by P.A.U. Education, S.L.

Web: www.epracticejournal.eu
Email: editorial@epractice.eu