Chapter 11
Tinkering Around Healthcare Infrastructures: Nursing Practices and Junction Work

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Abstract Introduction of healthcare infrastructures is often accompanied by workarounds, persistence of paper-based documents and of technologies that the innovation was intended to replace, raising the question as to whether they are by-products or intrinsic to infrastructure innovation processes. This work, through a longitudinal case study of a hospital information system long in use, investigates their origin, their role in enabling the system's affirmation, and the difficulty of eliminating them. Through a qualitative methodology, semi-structured interviews and ethnography, we reconstruct the history of the system and the information management practices around it. Our analysis reveals that the effectiveness of the tool implemented derived largely from 'junction work' performed by the nurses, which ensured the flow of data among different electronic and paper-based information systems. Moreover, in carrying out their junction work the nurses intervened to modify, enrich and complete the information contained in the different systems.

11.1 Introduction

Healthcare systems have been massively characterized by investments in ICTs since such systems promised to confer effectiveness and efficiency on healthcare structures and that the automated data management would have substantially simplified service activities for both doctors and patients [1]. The adoption of infrastructures was supposed to increase information exchange among diverse

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healthcare professionals which would improve inter and intra organizational coordination [2]. By now, however, that promise has been largely unfulfilled [3, 4]. Any simple activity intended to gauge the quantity and quality of the information systems operating in healthcare shows that a great deal of work needs to be done before these infrastructures fully respond to the needs of complex systems like those of healthcare [2, 5] mostly because medical technologies, even within a single operational unit, are unable to exchange information [6], which often require workarounds, and in which paper persistence is observed [7, 8]. Several studies have shown that this integration is problematic due to a superficial analysis of complexities at organizational level [6, 9, 10]. Expectations in regard to the introduction of health infrastructures has clashed with the organizational structures, professional practice, and often caught in a web of information systems devoid of connectivity and interoperability [11–13]. These experiences have emphasised the obstacles to work caused by these innovations and the gap between design and the reality of the clinical settings where such systems are implemented and used [14, 15]. The excessive trust in the standardization of procedures and the scant attention paid to workflows of individuals has been considered a key factor in determining these issues [10]. Post-implementation analyses show that the full success of innovation processes is infrequent, and that when healthcare information infrastructures are indeed successfully introduced, this comes about in ways and for reasons different from those hypothesised in the development and implementation phase. Elements such as workarounds and persistence of paper-based information systems and of the communication technologies that the innovation was intended to replace are often presented as by-products and indicators of incomplete realization of the project design [16]. The recurrence of these elements in different analyses, however, raises the question as to whether they can actually be considered by-products, or whether they should instead be interpreted as intrinsic to infrastructure innovation processes.

This paper concentrates on these phenomena investigating their origin, their meaning in the overall operation of the system, their role in enabling the system's affirmation, the difficulty of eliminating them, and, not least, their undesired effects on certain organizational processes. Through the analysis of the transformation of a teleconsultancy system into an Electronic Patient Record (EPR) we focus in the junction points among diverse infrastructures and the invisible work needed to manage the flow of information among them.

The paper is structured as follows. The next section introduces the concept of infrastructural inversion as proposed in Science and Technology Studies. The following section presents the research design and methods. The findings are set out in two sub-sections. The first outlines the history of the infrastructure, from its ideation as a platform for synchronous teleconsultancy to its redefinition as an EPR. The second sub-section describes the information management practices in that department, focusing on the activities by which the nurses made communication possible among non-interoperable systems. Finally, the discussion section considers the implications of the research, and particularly how activities, which enable

communication among non-interoperable systems. These activities are 'junction work' [17], not always eliminable, nor replaceable by infrastructures, precisely because of their intrinsic complexity and their organizational value.

11.2 Studying Infrastructures and Local Practices

Successful infrastructures rapidly become part of the taken-for-granted of those who use them [5]. They merge into individual actions and organizational practices, of which they become constitutive parts; and only when malfunctions or breakdowns occur do they re-acquire their visibility [18]. The strategy adopted here to restore visibility to our object of analysis goes by the name of 'infrastructural inversion'. This consists in shifting the attention from the 'tubes and wires' of the technical system to, on the one hand, the process of installing the infrastructure from design to implementation, and on the other, the work on and around the infrastructure necessary to keep it working [19, 20]. Retrospective analysis of infrastructure-in-the-making directs attention to the ethical, political and social issues, the conflicts, the negotiations, the compromises, and in general all the choices that have made the infrastructure into what it is. Reconstructing how an infrastructure has been created makes it possible to identify the key and peripheral actors, and to determine whether and how asymmetries of position have been incorporated into the technical object. The first paragraph of the findings will be devoted to this retrospective analysis.

Attention to the work necessary for the infrastructure to function is tied to the idea that infrastructure are such only in relation to organized practices, and that only in relation to these practices does it possess the characteristics of invisibility and taken-for-grantedness [21]. Shifting the focus from the users envisaged by the designers to those who work to keep the infrastructure functioning makes it possible to observe the competences, complexities, and the workarounds necessary to maintain the infrastructure within a broader infrastructural system. This will be discussed in the second paragraph of the findings section.

Our approach consists in shifting the attention from the infrastructure as a mere technical device (tubes and wires) to the activity meaningful to the organizational actors involved. In both the sections, our units of analysis will be the organizational practices defined as "the ways, relatively stable in time and socially recognized, in which heterogeneous items are ordered into a coherent set" ([22], p. 34).

Organizational practices have two characteristics.

- **A practice must be 'named' as a specific object of study, knowable from the outside, known to the researcher and to the actor as well**. It consists of regularities or schemes that guide the linkage with other practices. Finally, it is imbued with meanings socially accepted by the organization, which allow its reproduction with a certain stability over time.

- **Performing a practice involves 'knowing in practice' rather than an abstract knowledge**. A practice is a process, a negotiated symbolic order that emerges from its function in the organization. Through practice, connections and constraints among the resources available are learned, together with a practical knowledge that allows the management of practice's unpredictable trajectories and the linkage of several practices into a broader set.

We shall concentrate on two types of practices. The first are the 'medical practices of the future' imagined by the designers and by the doctors involved in design of the system and engaged in constructing a new technical system and redefining the roles of the users as mediated by the system itself. This will enable us to observe the different degrees of involvement of the actors concerned, the decision by some of them to withdraw from the project, and the substantial redefinition of the infrastructure's overall purposes. The second set of practices analysed are those of the nursing staff, which were not expressly foreseen in the design phase and emerged during the infrastructure's implementation and everyday use. These practices will enable us to observe how the introduction of the infrastructure produced effects in areas different from those expected. We shall focus in particular on the nursing activities that enable the transfer of data among non-interoperable systems (junction work).

11.3 Research Context, Research Design and Methods

The research in what follows is the preliminary phase of an evaluation of communication practices in the oncology Day Hospital (DH) of a regional hospital with 10 doctors (full-time), 11 nurses (7 full-time, 4 part-time) and 2 secretaries. The DH treats around 60–70 patients a day plus those who arrive via Accidents and Emergency. The oncology department is the only one of its type in the region, and it handles patients from a mountainous catchment area of around 6200 km^2. The doctors at the outlying hospitals consult with the specialists in the department observed by our research, and refer the most complex cases to them. For more than 10 years, the department has used SYS (fictitious name), an EPR developed as a pilot project whose history will be detailed in the findings section.

We started with an exploratory study (2 weeks) intended to gain an overview of the kinds of information management in place since 2010, understanding the tasks associated with document management, the tools (electronic and otherwise) used, and critical areas. Preliminary observations showed that the doctors managed both clinical and administrative information almost entirely by means of the EPR, whilst the nurses used numerous other information systems, both paper-based and digital, spending most of their time on duplicating information present in diverse systems to ensure the flow of information within the department, among different departments, with the hospital administration, with other hospitals, with the clinical analysis laboratories.

Following this exploratory phase, two research questions were formulated: (i) what are the obstacles against the deployment of a infrastructure, and what adjustments does the organization make to overcome them? (ii) from an analytical point of view, in what does junction work among the various systems consist? These questions were addressed with two research actions:

- Retrospective reconstruction of the ideation, development, and implementation of SYS. This objective was pursued through semi-structured interviews with members of the IT research team (managers, computer scientist and developers of the IT centre which managed the design) and accounts furnished by the department's doctors and collected during the observation period (see below).
- Analysis of the information management practices of the department's nurses. This was carried out in 8 weeks of observation of the day hospital nurses across 6 months, seeking to cover the department's life cycle as far as possible. Observed each week was a nurse engaged in a specific practice (taking blood samples; paper-based clinical records retrieval; chemotherapy infusion; reception; assisting the doctors during examinations; coordination). Two of these settings, reception and coordination, required 2 weeks of observation each.

The ethnographic technique selected for the fieldwork was shadowing consisting in flanking an organizational actor to track and reconstruct his/her activities, paths, and intersections with other actors and processes throughout the working day [10, 13]. Shadowing of personnel with greater seniority, like those to whom priority was given in our research, allows to reconstruct the evolution of activities insofar as the shadowees are willing to describe how tasks were performed in the past, the relative changes made to procedures and rules, as well as their perceptions of change in their roles during the process. The shadowees described the changes in information management following the introduction of SYS in the department in relation to the hospital's information systems subsequently introduced. It was thus possible to integrate the information collected on the history of the project with the interviews conducted with the researchers and developers of the SYS system. The materials collected and transcribed were analysed first through historical and retrospective reconstruction that used turning-points in the project as its units of analysis, and then through reconstruction of the everyday work performed by the nurses to ensure that the systems produced the effects for which they had been designed. All research activities have been carried out from fall 2009 to spring 2010. These activities included collecting documents related to the first phases of the project.

11.4 Infrastructures, Local Practices and Junction Work

The historical reconstruction of the process that had led to SYS enabled identification of two significant turning-points: the withdrawal from the project by all the hospital departments involved except the oncology centre and the decision to

re-orient the project on the oncology department by transforming an infrastructure enabling inter-department communication into a tool for intra-department information management.

11.4.1 Birth and Abandonment of the Territorial Infrastructure

SYS is the result of a process started in 1997 to create a synchronous teleconsultancy tool for the shared management of cancer patients between the medicine, gynaecology and dermatology departments of five outlying hospitals in a region of northern Italy and the oncology unit of the region's central hospital. The purpose was to make the competences of the region's sole expert centre in oncology available to all the outlying hospitals through a telecommunication system that would allow the simultaneous navigation of electronic pages and discussion of the patient's data supported by an audio channel on IP, a chat tool, and a shared board for the visualization and annotation of diagnostic images. The envisaged advantages of the project were the possibility to take more accurate decisions and to avoid travel by oncologists from the central unit to the outlying ones to furnish consultancy.

However, from the design phase onwards, the doctors at all the centres involved expressed doubts as to whether it would be possible to hold regular sessions of synchronous teleconsultancy given the often unpredictable flow of the department's activities. This led to the integration into SYS of an asynchronous teleconsultancy tool based on text messages. After this first design phase, the heads of the peripheral departments lost all interest in the original project claiming that the asynchronous teleconsultancy was all they needed.

11.4.2 Implementation of the Information Management Practices and the Interconnected Infrastructure

The lack of commitment of the majority of hospitals and doctors jeopardized the whole project. The existence of SYS is due to the continuing interest in it of the oncology unit of the central hospital. A crucial role was performed by the newly-appointed chief consultant, who re-oriented the entire synchronous teleconsultancy project to the production of a oncological EPR tailored to the management of the department. The chief consultant's determination to develop this infrastructure was substantially due to two factors. Firstly, he wanted to introduce the processes of information automation that he had experienced at his previous hospital. Secondly, his desired to reorganize the work practices setting up a model whereby every oncologist would be able to treat every patient, thus superseding the current organization of work whereby each patient was treated by a single doctor. The SYS, he believed, was the instrument best suited to the sharing of information about patients among the various doctors [23].

To this end, SYS was designed so that it compelled the doctors to standardize information as far as possible (i.e. by reducing the text boxes and increasing the structured information). When planning the system, the designers worked in close contact with the oncology medical staff as regards both the information to enter and the procedure for doing so. In particular, SYS was structured by files, each of which contained information on one step in the treatment process, so that the oncologist could be followed/guided as he or she entered information during examination of the patient. The design of SYS thus proceeded *pari passu* with reorganization of information-management practices jointly with the oncologists. In 2000 the EPR was officially adopted in the department, first by the medical personnel.

In this first phase, the SYS application allowed the management of strictly clinical information. However, the first trials showed that clinical practice required the doctors to manage information of other kinds as well. This led to requests for further functionalities, such as management of administrative information, compilation of the department diary, the booking of clinical tests, specialist examinations, and so on. In short, the doctors requested the IT research team to develop tools for the management of information present in other systems (paper-based) and mainly managed in the department by the nursing staff.

The nurses, despite the system was supposed to be used by them as well, were not involved in the design process. This was partly due to the clinical record's symbolisation as an artefact of direct pertinence to the doctors. The main reason for their exclusion, though, was the close bond that had formed between doctors and designers. After the loss of interest by doctors of the outlying hospitals, nor the designers nor the doctors wanted to put the project at risk. Including the nursing perspective in SYS was regarded a possible source of destabilization of a project which, after a traumatic start, was becoming to have promising outcomes. Whilst doctors could speak for themselves when discussing with the designers, the nursing staff could not make their voice heard and was obliged to adjust to the changes. As a result, some nursing activities were inscribed in the SYS. The most significant of these was the requirement that SYS data should be entered manually through data entry templates. Some information entering and exiting the system requires work by the nursing staff to transfer/copy the information contained in SYS, or to transmit it to other paper-based and electronic information systems through an activity we call here junction work.

Over time, the number and the type of data entry templates have undergone changes because of modifications in the SYS's capacity to interface with other information systems. For example, the need to enter the results of blood tests manually has decreased since SYS was made interoperable with the inter-hospital system, so that the operation is necessary only for results from private laboratories. The opposite case is represented by the birth of new services, (e.g. CT or PET scans), for which it has been necessary to create templates for recording appointments.

We shall now discuss the implications of this for the nursing staff.

11.4.3 Junction Work and Nursing Practices

The introduction of SYS into the practices of doctors and nurses had different effects. For the doctors, the use of SYS was an integral part of fluid working practices almost entirely paperless. For the nurses, instead, SYS was sometimes an element that disrupted the orderly flow of work activities as they were delegate the task of feeding the SYS with the information that the system cannot receive automatically from other information infrastructures.

Paper-based documentation reappeared on the admissions counter, in the department's corridors, in the secretaries' offices, in the infusions rooms, and more generally, everywhere that nursing practices took place. And alongside the documentation were staplers, fax machines, telephones, photocopiers, paper clips, post-its, all the physical and 'analogical' equipment required to manage documentation.

Preliminary observation revealed the complex interplay between the paper documentation and SYS, and the role performed by nursing staff so that the doctors could work (almost) exclusively with the latter. Research thus shifted from the infrastructure to the activities going on around it. In this section, we concentrate on these activities, and in particular on junction work, by which is meant actions intended to "facilitate the exchange of data among different information systems (both electronic and paper-based) involving direct and explicit action to overcome barriers impeding data exchange among two or more of them. These activities may take the form of the transcription or digitization of dates, their transfer from one system to another with memory devices (e.g. USB keys, hard drives) or manual uploads, changes of format, and so on" [20].

Our ethnographic observation showed that such activities assumed very different forms in the department according to the information and the information systems to be linked. Only rarely did they consist solely of the simple transcription of data from one system to another. More frequently, the transfer of information between information systems required multiple operations, the use of different tools, the collaboration of several nurses over an extended period of time, as shown by the procedure for booking Positron Emission Tomography (PET) in Box 11.1.

Box 11.1. PET Request Management

The doctor compiles the request for PET on a paper-based form and hands it to the nurse, along with the patient's clinical record, when s/he is accompanied out of the surgery after the examination. The nurse faxes the request to the nuclear medicine department (where the PETs are performed), clips the fax receipt to the original, puts the sheets in the folder and takes it to the admissions counter. The admissions nurse, as soon as she finds the time to do so, puts the folder in a cupboard on a specific shelf marked 'PETs without appointments'. After some days (three approx.), the secretariat sends

(continued)

Box 11.1. (continued)
the reply from the nuclear medicine department to the admissions counter. This reply is the same fax sent by the first nurse with the date and time of the appointment hand-written in one of its corners. The arrival of the fax means that the nuclear medicine nurses have registered the appointment in the Hospital System (HS). The oncology nurse takes the folder from the shelf and attaches the fax to its front with a paper clip. She then searches the SYS register for the patient's telephone number, and the department's diary for a new appointment date which falls some days after the PET appointment so that she can be sure that the doctor can carry out the examination when the PET results have arrived. She transcribes this information (telephone and new appointment) on the booking fax in order to have all the information to give the patient on a single sheet of paper. The folder will remain on a corner of her desk until the patient has been informed (if s/he cannot be contacted, the folder may remain on the desk for hours/days). Only then is the appointment entered into the SYS diary. The nurse then writes on the fax that the patient has been informed about the appointment. She puts the fax sheet in the folder, which she places on the shelf of the cupboard marked 'PETs with appointments'. On the day of the PET, an auxiliary will take the folder and accompany the patient to the examination room. Although the folder is an almost exact duplicate of the SYS, doctors in other departments, for which SYS does not have legal value, require it.

This is a particularly complex case of junction work among those observed, and it has been described here because of its exemplary value. In other cases, presented below, the activities connected with the transfer of information among unconnected systems are less intricate, with a smaller number of operations, technologies, and actors involved. Analysis of the example, however, makes it possible to grasp some distinctive features of junction work.

Firstly, in a complex organizational context, the transfer of an item of information between systems not directly interconnected requires a series of activities that involve diverse actors in a variable period of time, which depends on numerous factors. In this case, complexity derived from a mix of factors among which the differing procedures followed by the departments, the cooperation of the nuclear medicine department, the telephone contactability of patients, as well as the decisions of the department's nurses to perform other activities deemed more urgent.

Secondly, the action of the nurses in the management of information is never directed to the simple transfer of a datum from one system to another. At each step, the nurses work to facilitate intra-/extra-department coordination through the matching of information to create data sets useful for performance of a particular duty. For example, the information relative to an appointment is always linked with other data and documents (fax receipt, clinical record, the patient's telephone

number) useful for managing a task more complex than the simple transfer of information from one system to another. The entry of the examination date into the SYS is only one segment of more general junction work among colleagues, with the doctors, with other departments, as well as with the patient. These tasks are accomplished through junction work among documents: clipping the fax receipt and the appointment request together so as to register the handover between departments, putting these documents into a folder so as to keep everything necessary for the PET together, annotating the patient's telephone number and the date of the new appointment on the fax in order to facilitate communication with the patient by colleagues, and so on.

Thirdly, the junction work is supported by a shared topography of organizational environments that assigns a space to each stage of the information processing. The secretariat, the 'PETs with/without appointments' shelves, part of the admission nurse's desk, are all spaces dedicated to information (in its paper-based materiality) in transit between the two computer systems. This mode of work enables the nurses to understand with a glance both the stage reached by the process and the composition and weight of the activities still to perform.

Finally, the junction work is the outcome of a series of micro-actions situated within other, broader working practices undertaken in different ways. In the case in question, for instance, the notification of the appointment by fax, coupling with the receipt, and delivery to the admissions counter, are actions that interrupt the activities in which the coordination nurse is engaged. Vice versa, the information search in SYS, the booking of the appointment, the telephone call to the patient, and placement of the folder in a special space, are actions that the admissions nurse performs in sequence.

This last point requires closer examination. During the research it was observed that there are three types of relation between junction work and nursing practice:

- Junction work disrupts a practice;
- Junction work is an integral part of a practice;
- Junction work marks out boundaries among distinct professional practices.

Some examples will illustrate these distinctions.

11.4.4 Junction Work Interrupts (or Interferes with) a Nursing Practice

In some cases, the lack of interconnection among systems required the nurses to interrupt the normal flow of their practices. These were the most frequent cases of junction work identified. We now describe the exemplary case of orchestration of the flow of patients through the department performed by the 'coordination nurse', a role that requires a perfect knowledge about the department's overall functioning and the timing of its activities. She supervised the flow of patients from the reception

counter, their transit to the infusions rooms, and the dispatch of requests to the pharmacy for medicines. More generally, she had to ensure that patients, medicines, or information arrived on time where they were supposed to arrive. This practice required constant monitoring by computer or telephone, or by going in person to verify what was happening.

Besides these activities, one of the tasks required of the coordination nurse was keeping account of the flows of patients and medicines in the department. Although this was an activity that did not figure among coordination tasks, it was useful for statistical/administrative purposes. It consisted in compiling forms with information contained in the printouts of pharmacological therapies and in the hospital's electronic information system and SYS. This junction work served to replicate in a new document information present in other information systems (both paper-based and electronic) and required the nurse to put coordination on stand-by.

Specifically, whenever a therapy was administered, the doctor placed the prescription on the nurse's desk (around 40 times in a morning). This prescription had to be sent to the hospital pharmacy for preparation of the drugs. First, however, the nurse had to transcribe the information on the paper-based form. The coordination nurse gave different priorities to this activity according to flows in the department. But it was usually a task attended to before others, because failure to perform it blocked a series of connected activities (preparation of the drugs, the patient's dispatch to the chemotherapy unit, beginning of the drugs infusion). In this case, the junction work between the SYS (where the prescription has been compiled) and the paper-based accounting system interfered with the nurse's other activities and increased the risk of errors. The nurses admitted, in fact, the forms had only indicative value because during the hours of heaviest workload, they were compiled in a chaotic environment.

11.4.5 Junction Work as an Integral Part of a Practice

In other cases, the transcription of information from one system to another does not have disruptive effects on a practice but is an essential part of it, as happens in the case of the booking of blood tests. The procedure is that the doctor prescribes the test by entering the information in SYS. Given that SYS and the analysis laboratory's system are not interoperable, the nurse must do the junction work of transferring the prescriptions to the latter (so that the doctor can work only with SYS, without using the hospital system). This work is performed every morning by a nurse who devotes the first hours of her shift to blood sampling, a work practice that consists in the complete management of both the sample and the information connected with it (e.g. printing the adhesive labels and affixing them to the test-tubes containing the blood). The junction work here consists in entering the tests requested by the doctor via SYS into the hospital system. To perform this operation, the nurses usually print the pages of SYS because their computer has only one screen.

While performing this practice, however, the nurse checked the tests requested by the doctor and intervened in two ways: informing the doctor about some missing tests, or even directly adding them to the list. This typically happened when the doctor had not included among the tests requested those that enabled the anaesthetist to evaluate the patient before inserting a portacath. This instrument serves to ensure that the chemotherapy treatment is administered causing least possible damage to the patient's veins. The nurses were very sensitive to this aspect because, as one of them said, "it's awful to see a patient attached to the infuser for hours and hours with burning veins". Moreover, as said by another nurse in another circumstance, patients who suffer during the therapy require greater care and attention. In these cases, it was routine in the department for nurses (especially those with greater length of service) to intervene directly by introducing new tests and subsequently reporting them to the doctor.

In this case, unlike those described previously, the junction work between the systems is not a mechanical operation but rather an activity in which the professional skills and the experience of the nursing staff play a significant role in verifying and integrating the information so as to facilitate other work practices (e.g. improving the patient's comfort and his/her ability to tolerate the infusion).

11.4.6 Junction Work as a Boundary Among Different Practices

Finally, in several cases interconnection between SYS and other systems, although technically feasible, was not considered desirable. The lack of connection between systems was functional to showing the differences between professional roles and competences by distinguishing between medical practices and administrative ones.

The most representative case was management of access to the car park reserved for oncology patients. For the latter, the hospital had reserved an internal car park, access to which was regulated by a bar that the patient raised by swiping his/her health card managed by a specific information system. The regulations on access imposed a maximum number of accesses for a limited period of time. The decision on times and accesses was taken by doctors according to the type and duration of the therapy administered to the individual patient. The procedure was that the doctor wrote this information (e.g. ten accesses authorized for the next 60 days) in a text box of the SYS. The printout was given to the patient, who took it to the department office. Here the secretaries entered the information into the software dedicated to management of the car park, thus activating the permit. The limits of time and access to the car park, however, could be redefined according to the progress of the patient's disease. A period of weakness or the toxicity of a drug, for example, might lead to suspension of the therapy, and to a request for the period of parking permission to be extended. Likewise, patients could go to the department without an appointment

if their condition had deteriorated and required an increased number of accesses to the car park. In these cases, changes and extensions were directly managed by the secretaries.

In this case, the lack of connection between systems and the junction work that this required was functional to marking out different professional practices, as emphasized by the secretaries. Although an information system could automatically establish the times and number of accesses and send them to the system managing the car park lot, it would not be able to handle exceptions. The delegation to the secretaries seemed intended to make the patients understand that all the procedures concerning management of access to the car park were to be performed without consulting the doctors, thereby marking out a professional boundary between competences.

11.5 Discussion

Before we proceed any further we need to answer a simple but fundamental question: can we consider the SYS just a case of bad design? Should we answer positively junction work could be regarded as a mere by-product of a poorly designed information system. Much of the observed junction work, after all, could have been avoided had the nursing staff being involved in the making of the SYS. Their exclusion is a breach of the key principle of participatory design: actively involve all relevant stakeholders. The historical analysis, however, offers a more complex explanation. It suggests that after the outlying hospitals backed off the project the main concern of designers and doctors of the oncological department was strengthen the collaboration ties to keep the project alive. The inclusion of nursing staff would have helped to have a comprehensive picture of the requirements but it was regarded as a source of uncertainty in a process that had already been close to a failure.

The infrastructural inversion invites to reflect on a different question: bad design for whom? Doctor and nurses have different representation of the infrastructure and for the former the SYS has improved their work practices eliminating most of the clerical tasks now delegated to the latter.

In more general terms, directing our attention at the points of juncture between the infrastructure and other systems and the work practices necessary to connect the former to the latter made it possible to observe how the fluid integration of the infrastructure into the medical practices partially relied on the ability of the surrounding socio-technical system, and in particular on the junction work of the nurse and secretaries, rather than being an intrinsic property of the infrastructure itself. The infrastructural inversion [5] confirms the process of co-construction between organizational practices and the infrastructure, demonstrating the impossibility of separating technology and organisation [24]. Nevertheless, although implementation processes lead to changes not foreseeable at the outset [2], some actors can exert closer control over the final outcomes. The greater capacity of some

actors (doctors) to reshape their practices as they preferred enabled them to render the system into a taken-for-granted infrastructure by delegating, through that system, work to other organizational actors (nurses and secretaries) obliged to change their work activities in order to accommodate the new technology. Moreover, a trade-off was observed between the possibility of the doctors to make SYS their main tool of information management and the professional content of the work of the nursing staff. In the opinion of the nurses with longer service in the department, over the past decade nursing work had been characterized by an increase in information and document management, with the effect of substantially modifying job profiles (for specific treatment see [17]. Observation of nursing work in the day hospital showed, in fact, that it comprised a large amount of information management, and to a lesser extent, actions directly concerning the care and assistance of patients. With the exception of the chemotherapy unit (where patients were constantly monitored and assisted), most of the work time in all the nursing tasks observed was devoted to retrieving, filing, and transferring information about patients.

A second consideration concerns the genesis and persistence of forms of paper-based information management. In the case described, one cause of this phenomenon was the distinctive history of the infrastructuration project and the change made to its purpose. The decision to create a system enabling the doctors to manage almost all information using a single system required integration with the other sources of information present in the department and in the hospital, many of which were paper-based. However, this only partly explains this persistence. As we have seen, in fact, forms of junction work also persisted where the systems to be integrated were electronic and their elimination did not seem always easy to achieve. Although the junction work always consisted in the transfer of information from one system to another, it assumed different dimensions according to the content of the work, the skills required for its execution, its timing, and the actions necessary for its automated performance (Table 11.1).

Observing junction work on these four dimensions reveals its relations with work practices, being at times an obstacle to work practices, an integral part of them, or in yet others it is an organizational practice in itself which comprises different skills.

In the first case (e.g. tracking the consumption of medicines), interoperability between different systems appears both feasible and desirable for the actors

Table 11.1 Dimensions of junction work (rows) and their relation to organizational practices (columns)

	Interference with practices	Part of a practice	Organizational practice per se
Content of the work	Data management	Data management + professional knowledge	Data management
Skill required	Mechanical	Expert	Expert
Timing	On call	Predictable	Adaptable to the workflow
Eliminability	Enhancing interoperability	Not possible (or extremely complicated)	Not desirable

involved. The nurses would welcome integration between systems, which relieved them of a mechanical work they are required to perform on call and they considered tiresome, at constant risk of error, and consisting in mere mechanical transcription.

The second case is different (e.g. transfer of prescriptions for blood tests). Here the junction work is not immediately eliminable except at the price of an overall decrease in the quality of performance. In the example given, the junction work appears to be a moment exploited by the nurses to deploy their expert knowledge (checking the completeness of the medical prescription) and to connect the practice of blood sampling with that of chemotherapy infusion, ensuring that the patient has been prescribed the insertion of a portacath. Moreover, the junction work needs to be performed at a given moment of the blood sampling practice and its predictability allows for a smooth accommodation in the workflow. In this case, the skills and knowledge of the nursing staff would be bypassed if seamless communication existed between the systems. In this case, elimination of the junction work, the amount of care given remaining equal, would substitute the work currently performed by the nurses by including in the infrastructure expert systems able to alert doctors or nurses of wrong or incomplete prescriptions. At present, however, the substitution of a human actor's expertise with that of a computer system does not seem feasible.

The third case illustrated (e.g. car park access) instead demonstrates that there are situations in which integration between systems, although technically feasible, is not organizationally desirable because the junction work serves to mark out distinct professional practices and competences, specifically to avoid that doctors perform strictly administrative tasks. In the example given, the lack of integration between SYS and the system managing the car park barrier was the occasion for handover between the medical personnel and the office staff, which demarcated their different professional domains and made explicit to patients who they should ask for extensions of their car park access. In this case junction work is an organizational practice in itself, performed by expert personnel and integrated in their daily routine.

On this basis, it can be argued that a lack of interoperability is not in itself a negative factor in all circumstances. Consequently, its elimination need not always be a priority when installing systems. It is instead more significant to consider the relation between junction work and organizational practices. From the analytical perspective outlined in the second section, following Gherardi [22, 25] we have defined organizational practices as socially recognized ways in which heterogeneous items are ordered into a coherent set. In this framework, support for clinical activity must consider practices ('coherent sets') rather than their individual elements, the purpose being to make practices more flexible. Hence, the work support furnished by new infrastructures should enable actors to construct courses of action meaningful to them. The elimination of a task (for instance, by means of a new infrastructure), therefore, cannot be evaluated in and of itself, but only in light of its positive or negative contribution to the overall coherence of working practice. Consequently, the apparently mechanical operation of transferring information from one system to another that we have called 'junction work' – and which it is widely

believed could be eliminated by increasing interoperability between systems – may be a 'heterogeneous item' part of a 'coherent set' as an extraneous and disruptive element whose elimination should be evaluated case by case.

11.6 Conclusions

This study has sought to answer the question of why forms of paper-based document management still persist following the introduction of electronic infrastructures. Such persistence is often observed and it is usually interpreted as indicative of only partial success in the design and implementation of systems. The study has shown the relations among the introduction of an infrastructure, the work practices that it was intended to support, and the work practices of other organizational actors not considered at the design stage. Infrastructures can achieve the results expected of them in ways very different from those envisaged by the rhetoric of technological innovation. They do so by redistributing tasks rather than solving problems. Every new connection both lessens work for some and creates extra work for others. Junction work – the human and material activity of connecting systems together – signals the difficulty of creating a seamless web in a context like that of healthcare characterized by a plethora of different systems. The elimination of such work, however, cannot be considered only as an interoperability problem because, in some circumstances, its execution appears functional to the correct or desirable performance of organizational practices.

By reconstructing the process of infrastructure installation, it has been possible to observe the differing capacities of organizational actors to maintain or reinforce the homogeneity and fluidity of their work practices by delegating, via the system, service tasks to other actors. The latter, the nurses in our case, may see their work significantly modified in terms of both the skills required and their composition. This has a paradoxical implication for infrastructuring processes in the healthcare sector: intended to reduce and facilitate information management tasks, such processes end up by increasing the time devoted to them by organizational actors who in principle should not have be affected by them.

A limitation of this study is the risk of generalizing results obtained from research on the effects of the introduction of an ICT system in a single healthcare organization characterized by a distinctive history of infrastructuration. In the future, therefore, it will be important to verify these results by studying other healthcare contexts.

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