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# Between Representation, Reorganization and Control – The Informational Technification of Intensive Care Units and the Consequences

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*Abstract: Relying upon an ethnographical study in the field of intensive care medicine, the paper shows how economic requirements are restructuring medical knowledge and practice on intensive care units (ICUs). As such, emphasis is placed on the special role that the IT network plays in this reorganizing process. The digitalization process allows linking the monitoring system, not only with the electronic patient record, but also with the management information system beyond the ward. Thereby, the former socially and ethically closed sphere of the ICU is opened up to organisational and economical requirements. Presenting two examples from the case-study, the paper illustrates how the IT network allows the accounting department to control the organization of work on the ICU as well as displaying the way in which medical classification systems are transformed into economic indicators. Furthermore, the paper explicitly shows how the medical and nursing stuff deal with the conflict of objectives that result from this digitalization and economization process.*

Keywords: Intensive Care Medicine, Information Technology, Diagnosis Related Groups, Medical Scoring Systems, Digitization Process, Digital Technology, Ethnographical Studies in Medicine

## Introduction

**ONE OF THE** most significant developments in medicine over the last 15 years has been the introduction of advanced information and communication technologies. These technologies have a broad impact on every clinical section: on management, accounting, the structure of work, the professional practice of medical and nursing staff and the patients' experience of illness. On intensive care units (ICUs), the implementation of information technology takes place in a very special context, one which was already highly technical even from its beginnings, in the middle of the 20th century. With regard to the provision of life support or organ support for critically-ill patients, monitoring the body's signs was and is one of the most important tasks (for technology utilised in ICUs). Today a patient's vital signs are not only electronically monitored, controlled and visualized at the patient's bedside, but also in the nursing room, the doctor's room, and other functional rooms on the ward. Additionally, other technical devices such as mechanical ventilation, dialysis equipment or infusion pumps are also linked to the monitoring system, and the technical data produced by these machines are visualized in every room on the ward as well. Thereby, an informational technical network has been developed over time, which covers the entire ICU, even including the patient's body as well as different devices, machines and monitors.

For a few years now, an advanced digitization process has also been observable. This is especially evident in university hospitals where the patient records and the whole administration of ICUs have been transformed into electronic-data processing. Furthermore, this digitization process is now being introduced into non-critical wards as well. However, in non-critical wards, the electronic patient records are not directly linked with the monitoring system, as they are on ICUs. As such, this innovation on ICUs thereby allows for an automatic and immediate transfer of the medical and technical data to the electronic patient record (EPR). On the one hand, this can be seen as an improvement with regards to the manner in which work is organized on the ward. Monitoring and organizational activities become more efficient. On the other hand, the surveillance of the medical and nursing work also increases enormously. This is due to the fact that every procedure and every application has to be documented in the EPR on time and person. Thereby it is possible for the head of department to observe every task that is performed or, otherwise, overlooked by staff members.

In this respect, the digitization process has far-reaching consequences for the organization of work on the ICU. Indeed, as well as changing medical practice, diagnostic categories, and the very consultation itself, it also has an extraordinary impact by restructuring the medical practice according to new managerial and scientific criteria. Digitalization allows connecting the informational network of the

ICU with the clinical-information-system beyond the ward. Thereby, the former socially and spatially closed sphere of the ICU is opened up to the organizational and economic requirements of the clinical management. Economizing and standardizing effects are directly transferred to the patient's room and influence the organization of work as well as the decision-making process of the medical and nursing staff. In other words, we could argue that the informational network constitutes a new immediateness of market principles in the former non-economical sphere of the ICU.

Drawing on a comparative ethnographical study in intensive-care medicine, I will demonstrate in the following sections how this restructuring process takes place, how the medical and the nursing staff are dealing with it, and what the consequences of it are. To do so, it will be necessary to focus especially on the informational network (IT), because this network is the socio-technical medium which allows transferring new economical and organizational requirements directly to the ward. In the following chapters, I will, firstly, outline the methodological and theoretical background of the study (section 2). After that, it is necessary to describe the informational network of the ICU in detail (section 3). Referring to two examples from the study I will conclude by demonstrating how medical practice on the ICU has been reorganized according to economic principles (sections 4 and 5).

## Technification and Experience in High Tech Medicine: An Ethnographical Study in Critical-Care Medicine

The survey I am drawing upon is a comparative ethnographical study conducted in the line of the so-called workplace studies (cf. Knoblauch, Heath 1999; Luff 2000). It is part of a sociological project funded by the German Research Council and hosted at the Institute for Sociology at the Technical University of Berlin (www.wissen-medizin-technik.de).

The subject of the project, in a wider sense, was the question: In what manner are personal experience and the tacit knowledge of the users needed for the utilization of medical technology. To ask about the relevance of tacit knowledge in the application of technology has been a common approach in sociological disciplines such as industrial- and organizational sociology ever since the 1980s (cf. Böhle 1989, 1994; Collins, Kusch 1999). However, in medical sociology, especially in the German speaking area, it is a fairly new question, which first appeared in the 1990s with the increasing use of informational technology in hospitals and the health care system in general (cf. Dimitz, Lechner, Molnar et al. 1991; Schneider, Wagner 1993; Wagner 1993; Rammert, Schlese, Wagner et al. 1998; Wagner 1998). This technification process and the lack of studies on this subject in the German speaking area was one reason to transfer the question to a medical realm.

Another reason to choose a medical field for the investigation was due to the political changes in the health care sector in Germany. Ever since the mid 1980s, an ongoing reform process has characterized the German health care system. The intention of the reform process is to reduce health costs by implementing market principles in governmental health care services; principles such as competition, personal responsibility and others (cf. Buhr, Klinke 2005; Kühn, Klinke, Kaiser 2005; Flintrop 2006; Hollick, Kerres 2002; Vogd 2004; Simon 2000; Vogd 2006). For the same reason, since 2004, the introduction of prospective payment schemes in the statutory sector has been underway. In other high-income countries, for example, the USA, Great Britain, Switzerland or Australia, this process can also be observed.. Patient classification systems such as Diagnosis Related Groups (DRGs) have been introduced as reimbursement systems which do not refund the real costs of a patients hospital stay but do pay a lump sum based on the average cost of specific medical cases. Economic measures, such as these prospective payment schemes, budgeting, or financial cutbacks, are explicitly introduced to change the common usage of medical technology and pharmaceuticals in general. Thus, such developments are likely to significantly influence both medical knowledge and practice.

Both developments – the digitization and the economization of medicine – should be seen as the grounding points of the project. The intention was to investigate the changes in medical knowledge and practice related to these processes. Therefore, a clinical field was chosen which, from its very beginning, was highly technical: critical-care medicine. From the study of other highly technical workplaces, it is known that the use of technical devices requires both scientific knowledge as well as personal experience (cf. Böhle 1989; 2001; 2002; 2003; Rammert 2004). The aim of the study was to prove this point by examining the everyday practices within intensive care units, and to ask, whether and, if so, how the meaning of competence and experience is changing due to the digitization and economization processes.

To investigate these questions a complex qualitative methodology is required. The relation between knowledge and technology cannot just be questioned, it has to be observed. Since the application of technology is expected to be based upon tacit knowledge, and since tacit knowledge is conceived as a kind of competence and not as a cognitive knowledge (cf. Polanyi 1958; cf. Collins, Kusch 1999; Neuweg 1999), a methodological design is needed which allows one to also perceive the unconscious sphere of knowledge. With participant observation, for ex-

ample, it is possible to recognize inconsistencies between statements about handling technology and the actual behaviour, even if this difference is unknown to the actors (cf. Strauss, Corbin 1996; Bloor 2001). Relying upon participant observation, informal interviews, collective discussions, and document analysis, two different intensive care units - an internal and a surgical one - in a big university hospital were examined. On both wards, the researcher stayed for three months each and observed the handling and procedures of technological devices which are used in everyday practice.

The theoretical approach the study relies upon comes from the field of Science and Technology Studies (cf. Bijker, Hughes, Pinch 1989; Ilyes 2006). To understand the complex interrelation between the informatization and economization processes and the medical knowledge and practice on the ward, it is necessary to refer to a theoretical concept which allows one to emphasize the material and the social aspects of technology simultaneously. Therefore, I am drawing upon the theoretical approach of sociotechnical systems (cf. Rammert 1998; Rammert 1999) which distinguishes between two aspects of technology: the "mediating character" and the "machine effect".

To consider the "machine effect of technology" means focusing on the specific features a particular technology has and to outline the consequences stemming. The implementation of IT in intensive care medicine, for instance, demands that the staff is continuously engaged in activities related to the operation and renewal of the system: Constant training in software and hardware is needed to ensure the optimal performance of the equipment, and permanent attention is required to identify and adjust failure in the data processing. Or – to mention a positive effect of the digitization process – recording the vital signs of the patients can be done in a far more efficient manner. All these effects are special features of IT which cannot be provided by other technical devices in the same way. The "mediating character", in contrast, tends to focus on the norms and rules which are transported by a technology. Concerning the digitization process on ICUs, this focus allows observing the direct transfer of organizational and economical requirements from outside the ward to the workplaces on the ward.

Relying upon this concept of technology, a blind spot, evident in many other sociological studies on medical technology, can be avoided (cf. Timmermans, Berg 1997; Timmermans, Berg 2003). A number of such studies often focus, either on the social or the material aspects of technification, and thereby miss the way in which both aspects are interrelated, something which is an explicit goal of the present study. However, focusing on both aspects of technology allows one to observe both the consequences brought about by the implementation of IT, as a technological system itself, and the consequences caused by the organizational, institutional and economical norms transferred by the IT network.

In the following section I will describe the informational network on ICUs in detail.

## The Informational Network on Intensive Care Units

As mentioned above, intensive care medicine was already highly technical when it began in the middle of the 20th century. Its central role is the provision of life support or organ support for patients who are critically ill and who usually require intensive monitoring. Therefore, a high technical standard in diagnostical and therapeutical procedures has developed. Common technological equipment in an intensive care unit today includes, e.g. mechanical ventilation to assist breathing, or hemofiltration equipment for acute renal failure, monitoring equipment, diagnostic procedures, intravenous lines for drug infusions or total parenteral nutrition, nasogastric tubes, suction pumps, drains and catheters; and also a wide array of drugs including sedatives, antibiotics, analgesics, etc. Today, nearly every bodily function can, at least for a while, be supported or replaced in a pharmaceutical or technical way. Furthermore, there are many diagnostic procedures, such as radiology, magnetic-resonance imaging or other visualizing technologies, which demand that the patient be transported out of the ITU to other wards.

One consequence of the implementation of IT is the conversion from paper-based medical records to electronic patient records. Taken alone, already this development has led to a wide ranging standardization of medical knowledge and practice (cf. Dimitz, Lechner, Molnar et al. 1991; Berg 1996; Timmermans, Berg 1997; 2003). Nonetheless, implemented in the high-tech environment on ICUs, the digitization of patient records has further consequences. It creates what the author terms the *informational or digital network of intensive care units*. Linked with the electronic monitoring of the patient's body, on the one hand, and with the clinical management system, on the other, the electronic patient record constitutes a comprehensive informational network, which reaches far beyond the walls of the ICU.

The core of this linkage between the electronic patient record and the clinical management is built by a special kind of software, the so-called patient data management system (PDMS) (cf. Bergen 2000; Bencic, Gliencke, Huft 2004). This software is compatible with every other clinical management system, for instance, ordering and administration software, staff-planning systems or accounting soft-

ware, such as "SAP R/3" or "Oracle". Furthermore, the electronic patient record is also linked with nearly every technical appliance which is connected to the patient's body and which is producing informational data, such as the electronic monitoring, the mechanical ventilation, infusion pumps, and the hemofiltration machine, among many others. In contrast to the period prior to the introduction of the electronic patient record, it is now possible to transfer the vital signs of the patient as well as the functional data of the machines directly to the medical record.

To enable this data transfer a complex hardware system is needed: At every bedside, as well as in nearly every room on the ward, whether it is the emergency room, the nurse station and the doctor's room, or any other functional room, we can find *monitoring terminals* as well as *computer terminals*.

*Monitoring terminals* are connected to the patient's body and to the machines which support his/her organ's functions, such as mechanical ventilation or hemofiltration equipment. They measure the vital signs of the patient and the functional data of the connected machines; they visualize the information as graphs or figures and send it to the electronic patient record. Since the bodily signs, as well as the technical data, are quantitative measurements of pressure, temperature, volume, flow rate etc., they have to be converted into digital data before the monitoring system can transfer them to the electronic patient record on the computer. Using the monitoring terminals, the medical and the nursing staff are able to observe the vital signs of every patient or to check the alarms from nearly every place of the ward.

*Computer terminals* are used to administer the patient's data in the electronic patient record and to order medication or diagnostic procedures and so forth. To do so, every staff member has an individual access authorization, a user name and a password, which allow them to manage the data. But the individual access authorization also enables their supervisor and the clinic administration to control every activity by time and person. This leads to an increasing surveillance effect which I will illustrate in the following sections.

To summarize, we could state that by being attuned to the technical environment of the ICU, the digitization process constitutes an informational network which stretches much further than the ward's physical borders. By linking the electronic patient record, the electronic monitoring, and the clinical management system, it opens the hitherto socially and spatially closed realm of the ICU to external administrational and economical requirements (for a better illustration of the complex network see figure 1). Whereas up until now, the medical decision-making process was predominantly influenced by ethical arguments, presently, the medical and nursing staff are forced to take economical and administrational reasons into account. Controlling methods and efficiency standards of the cost accounting (like diagnosis related groups) or international medical standards (like scoring systems) are now directly transferred to the workplaces in the patient's room. Drawing on two examples from the case-study I will illustrate in the following sections how these standards are completely reorganizing medical knowledge and practice on the ICU.

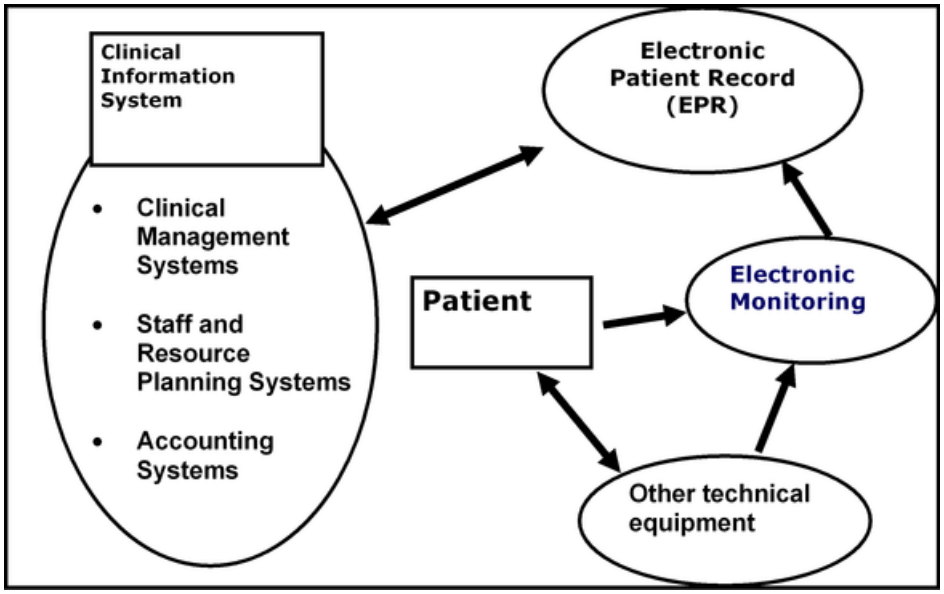


Fig. 1: The Informational Network of the ICU

## Transforming Medical Scoring Systems into Economic Indicators

Scoring-Systems are medical classification systems which were originally designed for the measurement of the morbidity or the severity of disease. Scoring-systems typically used on ICUs are: the Apache Score, TISS 28 Score, and the Glasgow Coma Scale, among others. The Apache-Score, for instance, is designed to predict the surviving probability of critically-ill patients. Once every 24 hours the medical and the nursing staff have to collect medical data and the vital signs of the patient, as well as having to calculate a score according to a special formula. The result is a number between 0 and 71 which functions as an indicator to evaluate the patient's morbidity. Initially developed in the late 1970s, presently, the third version is used in most ICUs. This third version is constructed to be used with electronic patient records. Based on electronic data processing it is possible to analyze the Apache-Score in comparison to 40.000 other cases from a US-American database. Additionally, combined with other scoring systems, the Apache Score offers a predictability of 95 % (cf. Rotondo 1997).

But medical scores are not only used as indicators of a patient's health. Being digitalized by the electronic patient record and required by the economizing process, medical scores are also transformed into financial and managerial indicators. That means scores are used, on the one hand, as a kind of expert system which supports medical and nursing decisions. On the other hand, scoring systems provide the background for organizational and economical decisions, too. In this regard, scoring systems are used in (at least) three different ways.

- Firstly, the indicators provide arguments for medical decision-making: Current studies from the US show that up to 50% of the decisions to terminate the medical treatment of terminally-ill patients are related to those indicators (op. cit.). Within the project the researcher could observe that in everyday practice using these indicators for medical decision-making was much more ambivalent. Scores are seen as just one aspect which has to be taken into account. The doctors and nurses always compare the information given by the scores to other medical and socio-technical information. They consider their own subjective impression of the patient's situation (including his/her social situation, relatives, personal needs and anxieties). They interpret the bodily signs of the patient, which are not shown by the monitoring system, for instance, skin colour, perspiration, frizzing, dryness and other qualitative aspects. And last but not least, they consider organisational, economical, educational and institutional aspects. In this way, they compensate for the deficiency of standardized knowledge: It never shows the real state of the patient's health because many relevant data are omitted.
- Secondly, these indicators are used as the background for economic decisions by the accounting department. In contrast to the medical realm, the question here is, whether it remains profitable to treat a patient despite his/her bad prognosis. And even though no direct intervention by the accountancy staff in medical decisions was observed, the growing importance of economic-based arguments on doctoral considerations was evident. The financial cutbacks on the ICUs are so restrictive that the doctors are forced to consider economic criteria in every medical decision they make. For example overstepping the allocated financial budget causes medical job cutbacks, as was observed on one ward. Moreover, the doctors know that the electronic patient record (which includes the scores) will be evaluated by the clinical administration every month. And after the patient's stay in hospital it is inspected by the experts of the health insurance companies, too. Combined with the DRG-system (see next chapter) the scoring systems are here used as indicators to assess the medical decisions with regard to their cost-effectiveness. In cases where there was a big gap between the given medication and the designated standards, the insurance would not pay the overall cost or the clinic administration imposes financial cutbacks to the ward for the next month.
- Thirdly, the scoring systems also serve as the background for the staff and resource planning on the ICU. The TISS 28 Score, for example, is designed to display the nursing work, by documenting medical treatments, like drug-infusions, diuretic-therapy, mechanical ventilation, hemofiltration, and so on. At the end of the month, the daily collected scores are added up and thereby an indicator is created which is used by the management as a criterion to cut back or to increase medical or nursing services. Yet, the problem with the use of the TISS 28 Score as well as other scoring systems is that they do not represent the real work which is done. Typical nursing practices, such as washing, feeding, making the beds, or psychological care, are not represented, because the scoring system only asks for medical and scientific data. Furthermore, it is not possible to change the scores individually or adapt them to special contexts, because scoring systems are international standards which are designed to compare the costs and the medical demands for similar cases in different contexts.

With these different meanings of the scores, inconsistent requirements are demanded from the staff. As part of quality management, they are forced by the administration to document every activity and every event accurately. But, according to the deficiency of the scores which do not represent the real work performed, by obeying the administrational requirements, the staff risk causing inadequate job cutbacks in the next month. Although the deficiency of the scores is well known to every actor - nurses, doctors, and even the accountants - no one really questions the relevance of the documentation. Moreover, they are sure that work has to be documented and represented in detail to ensure adequate compensation.

Furthermore, there is already a shortage of health personnel on the ICUs, which results in a kind of unspoken agreement between the staff to document as much as possible to prevent more downsizing. To manage these conflicting requirements the staff have to take into account the surveillance effect of the informational network: The linkage between the electronic patient record and the monitoring system rejects any information which does not fit, either in the standardized web forms or with regards the bodily or technical data. Insofar, the staff has no chance of documenting their real work.

But there are two more important results that should be mentioned. On the one hand, the surveillance effect of the informational network is not complete. The staffs still have and are able to develop options to facilitate their own as well as the patient's interests against the requirements of the economic and administrational standards. In the period of observation, what could be perceived is a growing gap between the documentation and the real work done. The unspoken, and predominant, criterion for the documentation is not used to represent the health state of the patient or the real work carried out, but, to use the electronic patient record as an instrument with which as much reimbursement can be obtained as possible. Therefore, a keen sense for the whole context is needed, both in dealing with the requirements of the informational network and serving the patient's necessities. On the other hand, it was evident that the ICU staffs do not completely reject the surveillance effect of the IT network. They complain about the pressure it places on their own work, but they also use it, at times, in a self-interested manner, such as in everyday conflicts between colleagues or professions, for example.

## Cost-Accounting by Diagnosis Related Groups

Another example of the standardization and reorganization of medical knowledge and work is the introduction of a diagnosis related reimbursement system into the hospital sector: the DRG System. Before the DRG System was introduced, in Germany in 2004, the health insurances reimbursed the actual costs a patient incurred during his/her hospital stay. Today, medical costs are calculated as a lump sum following the DRG System, which classifies medical cases in different groups according to their diagnoses, treatments and disease severity. These Diagnosis related Groups (DRGs) are assigned by a special kind of software, a grouper program, based on ICD diagnoses, procedures, age, sex, and the presence of complications or co-morbidities. The abbreviation "ICD" stands for "International Statistical Classification of Diseases and Related Health Problems", which is a medical classification system designed by the World Health Organization (WHO) to promote international comparability in the collection, processing, classification, and presentation of medical data. It is used world-wide for morbidity and mortality statistics, reimbursement systems and automated-decision support in medicine (cf. Hollick, Kerres 2002; Buhr, Klinke 2005; Kühn, Klinke, Kaiser 2005; Vogd 2006).

Compared to other countries where the DRG System is used, the German DRG System is highly individualized. It does not calculate the costs for a whole ward or a clinic but for a single case – which means per diagnosis not per person! In accordance with the findings of previous studies (cf. Buhr, Klinke 2005), in the present investigation, it was observed that this individualized character of the German DRG System has led to several negative effects for the patients. One example is what has been termed "case-splitting". Since health insurances only pay for a diagnosis related case, not for the person, a patient who is given an alternative diagnoses during his/her stay has to be released from the hospital and admitted again a few days later. This is necessitated by the fact that within the German DRG System it is impossible to be reimbursed for a diagnosis which did not exist or was unknown when the patient was admitted to the hospital.

For earlier versions of the DRG System – the first one was introduced in the USA in 1983 – the use of electronic data processing was not really necessary. The current version used in Germany, however, presupposes the digitization of the medical record and the clinical and administrational organization. Embedded in the informational network of the ICU, the DRG-system requires the same set of procedures as used in the scoring system, i.e. the meticulous and accurate documentation of the medical and technical data, the treatments, and all activities performed by the medical and nursing personnel. Including the maintenance of the soft- and hardware this results in an increasing amount of time and work which, in

turn, cannot be documented. Other studies have shown that the administration effort in hospitals after the introduction of the DRG System has increased so much that the reduction of costs resulting from the personnel cutbacks are more than offset (cf. Simon 2000; Buhr, Klinke 2005; Kühn, Klinke, Kaiser 2005).

That means, just like in scoring systems, the documentation of DRG relevant data is connected with contradictory requests: by following the required standards of documentation the staff, albeit unintentionally, assist in cutting back their very own jobs! This difficult situation is answered by the staff by the following procedure: Before leaving the ward to proceed to the accounting department, the electronic patient record undergoes a juridical and economical revision – "the diagnosis will be optimized", as a senior physician puts it. That means that the head of the department and the medical-data assistant sit together and review the electronic patient record for any eligible treatments which are accountable for but not documented – a process which already starts during the patient's hospital stay and which every physician is forced to conduct. They also scan the electronic patient record for incorrect statements, which could probably conflict with the international medical standards of Evidence-based Medicine.

This review has to be performed within the controlling frame predetermined by the monitoring system. According to this "optimizing procedure" it is, on the one hand, no longer possible to understand the electronic patient record as a representation of the course of disease. On the other hand, even the "optimizing procedure" is dependent on the monitoring effect of the informational network and thus, it cannot be performed in separation from what really happened with the patient.

## Conclusion

The two examples from this case-study have shown the relevance of the IT network on intensive care units in terms of reorganizing medical knowledge and work in accordance with economic-based requirements. By focusing on the "machine effect" as well as the "mediating character" of information technology, different aspects could be observed.

Focusing on the digitization process, particularly concerning its "machine effect" has pointed out the enormous efforts in time and work that the implementation of IT demands from the medical and nursing staff. It also allowed observing the increasing surveillance effect caused by the IT network itself, which means the linkage between the electronic patient record, the monitoring system and the clinical management systems.

Focusing on the "mediating character" of information technology enabled the researcher to observe the transfer of the economical requirements onto the decision making process of the ward. Via the informational network, economizing and standardizing effects of novel accounting practices – such as DRGs – are directly transferred to the patient's room and are influencing the organization of work as well as the decision-making processes of the medical and nursing staff. In other words, it was shown that the informational network constitutes a "new immediateness of market principles" in the former non-economical sphere of the ICU. Medical classification systems, formerly assigned to display the salutary status of the patient and to ease medical decisions, are now transformed into economic indicators, which are used by the management to control the work flow and the financial expenses of the ward.

As a methodological conclusion, we can summarize that investigating the social consequences of technification processes, such as the implementation of IT in health care, requires a theoretical approach which focuses on both the social and the technical aspects of technology. Furthermore, the examples have shown the advantage of an ethnographical methodology which allows one to rely upon both qualitative as well as quantitative methods. Observing the use of technology in its socio-technical context delivers a differentiated picture of the consequences of technification processes.

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