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Small Cause – Big Effect: Improvement in Interface Design Results in Improved Data Quality – a Multicenter Crossover Study

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Abstract. In Germany the core data set for anesthesia version 3.0 was recently introduced for external quality assurance, which includes five surgical tracer procedures. We found a low rate of correctly documented tracers when compared to procedure data (OPS-Codes) documented separately. Examination revealed that the graphical user interface (GUI) contravened the dialogue principles as defined in EN ISO 9241-110. We worked with the manufacturer to implement small improvements and roll out the software. A crossover study was conducted at a university hospital and a municipal hospital chain with five hospitals. All study sites and surgical tracer procedures combined, we found an improvement from 42% to 65% ($p<0.001$; N=34,610) correctly documented anesthesias. We also saw improvements for most of the observed surgical tracer procedures at all hospitals. Our results show the big effect small changes to the GUI can have on data quality. They also raise the question, if highly flexible and parameterized clinical documentation systems are suited to achieve high usability. Finding the right balance between GUIs designed by usability experts and the flexibility of parameterization by administrators will be a difficult task for the future and subject to further research.

Keywords: Usability, Forms and Records Control, Medical Informatics/methods, Information Systems, Information Systems/organization and administration, Secondary Use

Introduction

The object of this publication is to present the graphic user interfaces influence of the quality of data based on a recent experience report.

In 1999 the German Society of Anesthesiology and Intensive Care Medicine (DGAI) and the Professional Association of German Anesthesiologists (BDA) defined and established the core data set for anesthesia version 2.0. This data set enables uniform data collection for reports and external quality assurance. Several states of Germany have established quality assurance programs based on it [1,2].

Inferring on experience gained by data collection and analysis in 2009 and 2010, the core data set was revised. The authors introduced a set of five defined surgical

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procedures as tracers to enable multi-center comparison of intervention-specific characteristics [3].

Anesthesia information systems (AIMS) aim to improve the quality of data collection in daily routine [4,5]. To improve data quality and facilitate documentation the University Hospital Giessen and Marburg GmbH, Campus Giessen (UKGM-Gi) implemented the AIMS NarkoData (IMESO GmbH, Germany) [6]. We also applied the core data set version 3.0 on January 1st 2011 as an early adopter. And trained the physicians responsible for documenting the tracer procedures during or shortly after they were performed.

An interim analysis in early summer 2011 revealed a very low rate of recorded tracer procedures. Due to the availability of a redundant recording of surgical procedures, there was no immediate necessity for an intervention. Therefore, the decision was made to solve the problem of poor data quality by optimizing the Graphical User Interface (GUI) of the AIMS and not by training.

The aim of this study is to evaluate the impact of application of design principles as defined in EN ISO 9241-110 on data quality.

1. Methods

1.1. Application of design principles

First, we studied the GUI and applied the seven dialogue principles as defined in IEC9241-110 by usability experts [7]. The form in question contained a drop-down list to input the surgical tracer procedure labeled “tracer”. The first item and default value in the list was “no tracer” followed by the abbreviated names of the five tracer procedures. We found that the GUI contravened the dialogue principles, especially those of "suitability for the task," "self-descriptiveness" and "suitability for learning".

We cooperated with the manufacturer to change the User Interface control (UIC) from the drop down list to radio buttons (option buttons, OP) (figure 1). The items’ order of the items displayed was changed to make "no tracer surgery" the last element of the list. The Labels were rewritten without abbreviations and the control’s title was changed to "surgical tracer procedure". There is no preselected default value and the field is configured as mandatory, which requires the anesthesiologist to make a selection before completing the documentation. Other suggestions to improve usability, in particular for process adequacy, were postponed to another release to enable the investigation of the UIC.

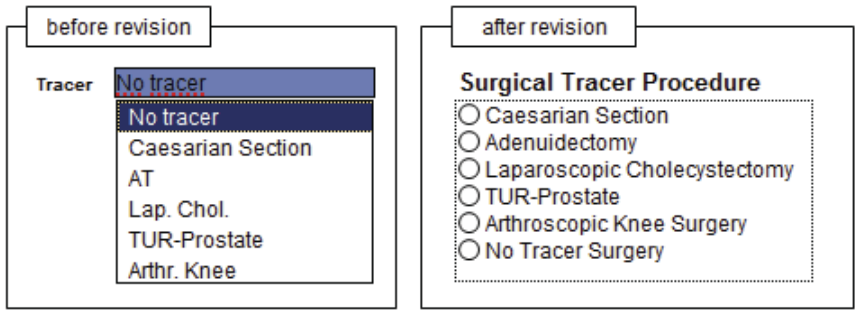

Figure 1. Compared Interfaces. left: drop-down list before revision; right: radio buttons after revision.

1.2. Evaluation

The study was designed as a multicenter crossover study. In addition to the UKGM-Gi, the study sites included the clinics Ostallgäu Kaufbeuren (C OAL-KF), a municipal hospital chain with five hospitals in Bavaria, Germany. We included only the four hospitals using the AIMS NarkoData. In October 2011, the modified AIMS version was deployed to all study sites. In order to exclusively investigate the effect of the new controls, there was no training or announcement for the employees primarily using the system.

After approval by local ethics committees (Ethic Commission of the Faculty of Medicine, Justus-Liebig-University and the ethics committee of the Bavarian state medical association) analysis was performed using unified database queries (SQL) at both study sites. The evaluation was performed over the periods before (p1: 01.01.2011-30.09.2011) and after the changes of the GUI (p2: 01.11.2011-01.12.2011). The time in October 2011 where excluded to reduce the error of time-shifted software distribution in the hospitals. The primary outcome parameters are the percentages of correctly coded tracer surgery procedures. The gold standard was the documented and encoded (using OPS-Classification, the German modification of ICPM) surgical procedure. We used SPSS Statistics (Version 19, IBM) and MS Excel 2010 (Microsoft) to analyze the resulting datasets. And we performed an exploratory analysis between the different time points. The time points were compared with the X^2-test.

2. Results

Table 1 lists the number of operating rooms in perioperative anesthesiology in 2011. At UKGM-Gi we recorded 16,027 anesthesias in p1 and 3,524 in p2, respectively at C-OAL in KF 12,269 in p1 and 2,790 in p2. Since the item was mandatory in both periods, there was no missing data.

All study sites and surgical tracer procedures combined, we found an improvement from 42% to 65% ($p<0.001$).

In a subgroup-analysis, we found an increase from 25% to 62% at UKGM-Gi ($p<0.001$) and an increase from 60% to 68% at C-OAL ($p=0.320$).

When looking at the individual surgical tracer procedures (see figure 2), we found improvements in almost all groups except two that showed a minor (but not significant) decrease.

Table 1. Number of operating rooms and perioperative anesthesias 2011 at the study sites.

				Hospitals of C-OAL-KF		
	UKGM-GI	**C-OAL-KF**	**Füssen**	**Kaufbeuren**	**Marktoberdorf**	**Obergünzburg**
number of operating rooms	33	18	3	8	5	2
perioperative anesthesias						
total	**19.551**	**15.059**	**2.818**	**8.178**	**2.898**	**1.165**
general and visceral surgery	3.055	4.390	762	1.576	891	1.161
gynecology	1.999	2.023	480	1.530	10	3
otolaryngology (ENT)	1.593	694	120	490	84	0
trauma / orthopedic surgery	4.273	3.420	868	1.785	767	0
urology	1.871	1.093	3	719	371	0
other	6.760	3.439	585	2.078	775	1

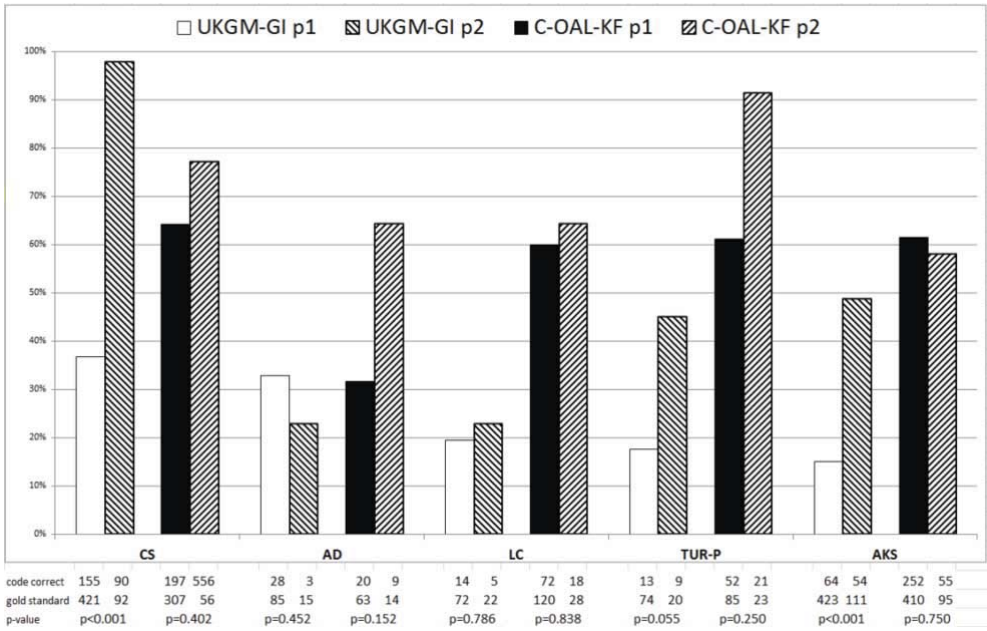

Figure 2. Percentage of correctly coded surgical tracer procedure (CS = caesarean section, AD = adenoidectomy, LC = laparoscopic cholecystectomy (without conversion to open technique), TUR-P = transurethral resection of the prostate, AKS= arthroscopic knee surgery) p1 = time-period before, P2 = time-period after changes in the graphical user interface.

3. Discussion

We could verify our hypothesis for most of the observed surgical tracer procedures. The subgroup-analysis however, only revealed two groups that significantly improved the ratio of correctly documented cases. This might be a result of the short time period 2, which was only two month long and therefore only contained a relatively small number of anesthesias.

The ratio in period 1 varied in the subgroups as did the measured effects in period 2. This could be attributed to different structures and environments, such as the existence of a recovery room, different workflows and staff involved. Further investigations and adjustments to ensure adequacy for the process are required. In spite of these clear findings we can only encourage cautious use of radio buttons, because a GUI's clarity is often disturbed by constant display of choices [7].

We found the best results when looking at the caesarean section as a procedure with a ratio of 98% in period 2. As patients are not observed in the recovery room after birth and the anesthesiologist is not replaced during the procedure, these factors might contribute to the good result. Also there are usually no patients waiting to be operated in the labor room, giving the anesthesiologist more time for proper documentation.

The importance of usability in electronic health records (HER) to improve documentation in patient care in the USA has recently been discussed [8]. The U.S. National Cancer Institute issued guidelines for usability [9], which underlines the importance of the subject.

This study might have a butterfly effect, as it raises far-reaching questions. On the one hand, clinical information systems should be as flexible as possible and extensive

configurability is expected. Thereby the responsibility for good software ergonomics is transferred to the system's administrator. On the other hand, one has to consider the large impact of small changes to the GUI on data quality. This raises the question whether hospitals and the clinicians involved have the expertise necessary for parameterization. The higher level of GUI expertise incorporated in specialized information systems could be one reason they rank higher in usability than hospital information systems [10].

Finding the right balance between GUIs designed by usability experts and the flexibility of parameterization by administrators will be a difficult task for the future and subject to further research.

Conflict of Interest

The authors declare that they have no conflict of interest.

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References

[1] Tisch R.Qualitätssicherung in der Anästhesie von DGAI und BDA". Modifikation des Kerndatensatzes Anästhesie und Kerndatensatz Anästhesie – Version 2.0 /1999. Anästh Intensivmed 1999;40:649-658
[2] Schwilk B, Junger A, Pützhofen G: Der Kerndatensatz Anästhesie – Version 2.0/1999 – Kommentare und Erläuterungen. http://www.aerztekammer-bw.de/10aerzte/05kammern/10laekbw/10service/40qualitaetssicherung/avb.pdf (Access 27.01.2012)
[3] Heinrichs W, Blumrich W, Deil S, Freitag M, Kutz N, Lüdtke I, Röhrig R, Streuf R. Kerndatensatz Anästhesie Version 3.0 / 2010; Anästh Intensivmed 2010;51:S33-S55.
[4] Branitzki P, Junger A, Bleicher W, Pollwein B, Prause A, Röhrig R, Specht M. Spezielle Empfehlungen und Anforderungen zur Implementierung eines Anästhesie-Informations-Management-Systems. Anästh Intensivmed 2007;48:282-290
[5] Raetzel M, Junger A, Röhrig R, Bleicher W, Branitzi P, Kristinus B, Pollwein B, Prause A, Specht M. Allgemeine Empfehlungen und Anforderungen zur Implementierung von DV-Sytemen in Anästhesie, Intensivmedizin, Notfallmedizin, Schmerztherapie Anästh Intensivmed 2005(46) Supplement Nr. 2/2005: S21-31
[6] Junger A, Benson M, Quinzio L, Jost A, Veit C, Klöss T, Hempelmann G. Quality documentation with an Anaesthesia Information Management System (AIMS). Anaesthesist. 1999 Aug;48(8):523-523
[7] Schneider W. Ergonomische Gestaltung von Benutzungsschnittstellen: Kommentar zur Grundsatznorm DIN EN ISO 9241-110. 2 edition. Berlin: Beuth;2008.
[8] Shneiderman B. Tragic Errors: Usability and Electronic Health Records. Interactions 2011: 18(6):60-63
[9] U.S. Department of Health & Human Services: Research-Based Web Design & Usability Guidelines. http://www.usability.gov/guidelines/guidelines_book.pdf (Access: 30.01.2012)
[10] Bundschuh BB, Majeed RW, Bürkle T, Kuhn K, Sax U, Seggewies C, Vosseler C, Röhrig R. Quality of human-computer interaction - results of a national usability survey of hospital-IT in Germany. BMC Med Inform Decis Mak. 2011 Nov 9;11:69