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Physicians' Attitudes Towards the Advice of a Guideline-Based Decision Support System: A Case Study With OncoDoc2 in the Management of Breast Cancer Patients

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Abstract

When wrongly used, guideline-based clinical decision support systems (CDSSs) may generate inappropriate propositions that do not match the recommendations provided by clinical practice guidelines (CPGs). The user may decide to comply with or react to the CDSS, and her decision may finally comply or not with CPGs. OncoDoc2 is a guideline-based CDSS for breast cancer management. We collected 394 decisions made by multidisciplinary meeting physicians in three hospitals where the CDSS was evaluated. We observed a global CPG compliance of 86.8% and a global CDSS compliance of 75.4%. Non-CPG compliance was observed in case of a negative reactance to the CDSS, when users did not follow a correct CDSS proposition (8.6% of decisions). Because of errors in patient data entry, OncoDoc2 delivered non-recommended propositions in 21.3% of decisions, leading to compliances with CDSS and CPGs of respectively 21.4% and 65.5%, whereas both compliances exceeded 90% when CDSS advices included CPG recommendations. Automation bias, when users followed an incorrect CDSS proposition explained the remaining non-compliance with CPGs (4.6% of decisions). Securing the use of CDSSs is of major importance to warranty patient safety and benefit of their potential to improve care.

Keywords:

Clinical decision support systems, Attitude to Computers, Guideline adherence, Breast cancer management.

Introduction

Variations in medical practices have been observed for decades around the world. If some level of variation related to differences in population need, health status or patient preferences, is expected, "unwarranted variation" raises questions about quality and appropriateness of care [1]. Following evidence-based medicine principles, clinical practice guidelines (CPGs) have been developed to eliminate these "unwarranted variations". Recommended by health professional societies or national health agencies, CPGs are information resources describing the recommended therapeutic management for different clinical situations encountered in given pathologies. They are thus intended to improve the quality of clinical care, reduce inappropriate variations, produce optimal patient outcomes, and promote cost-effective practices.

Many studies have shown that the sole dissemination of narrative CPGs had nearly no impact on physician behavior. On the opposite, numerous reviews [2] suggest that clinical decision support systems (CDSSs) have the potential to promote CPGs use. However, many studies showed positive effects of CDSSs, whereas others found only a limited impact of these systems upon physicians' behavior. One of the difficulty comes from the wide, non-totally agreed upon, meaning of CDSSs. This denomination covers indeed systems ranging from the simple provision of brief prompts and calculation services, through the provision of the therapeutic support for the management of complex patients with multimorbidity. CDSSs may also vary according to user interaction modalities, operating either as automated reminder systems generating alerts, or as on-demand systems. A recent study [3] reported for instance that presenting decision support within electronic charting or order entry system was associated with failure compared with other ways of delivering advice. In addition, requiring practitioners to provide reasons when overriding propositions and providing advice concurrently to patients and practitioners were more likely to be effective.

Cancer management is subject to practice variations and to varied levels of compliance with oncology CPGs [4].

Multidisciplinary meetings (MDMs), or tumour boards, are generally associated with improvements of guideline compliance rates [5]. However, the efficiency of MDMs has been recently questioned [6] and CDSSs used in MDMs are considered to improve the compliance of MDM decisions with CPGs [7].

OncoDoc2 is a guideline-based decision support system applied to the management of non-metastatic breast cancer patients to be used by MDM physicians [8]. Routinely used for three years in breast cancer MDMs of the Tenon hospital (Paris, France), it showed very good results in terms of compliance [9]. More recently, we conducted a prospective cluster randomized controlled trial to evidence the impact of the system on the compliance of MDM decisions with CPGs. When studying the sole intervention arm of the trial, where MDM physicians used the system for all breast cancer patients, we observed that, in half of the cases, the system was not correctly used. In theses cases, patients were described with "errors", and the compliance rate of MDM decisions was significantly decreased. We concluded that it was better not to use the system than to use it improperly [10].

Indeed, health information technology is expected to improve the quality of care. Tools such as electronic healthcare records (EHRs), CDSSs, computerized provider order entry systems (CPOEs), are believed to make the delivery of healthcare safer, more effective and more efficient. However, with the widespread implementation of HIT, studies that suggest HIT introduces unpredicted and unintended adverse consequences (UACs) potentially harmful for patients have been published. Campbell et al. [11] have identified 9 types of UACs, among which the Type 7 category (new kinds of errors) covers the concept of "e-iatrogenesis" defined by Weiner et al. [12] as "patient harm caused at least in part by the application of health information technology". These errors, known as technology-induced errors, are the result of a mismatch between the functioning of HIT tools and the real-life demands of healthcare work. Sittig and Singh [13] reported that UACs of HIT occur when HIT is unavailable for use, malfunctioning during use, or used the wrong way. Usability engineering methods are thus increasingly being used to ensure improved system usability and the safety of HIT applications [14].

When studying the non-compliance of physician decisions with *state-of-the-art CPGs* while using a guideline-based CDSS, e-iatrogenesis is not always involved. Physicians may not comply with the system propositions and not decide according to the best evidence for the patient. But they may also *comply* with the system propositions and not decide according to the best evidence for the patient. Two main scenarios should be considered. In the first one, the CDSS is correctly used and propositions are "correct" but physicians do not follow them. This corresponds to the mechanism of "reactance" borrowed from cognitive engineering, and introduced by Vashitz et al. [15]. Psychological reactance is an unpleasant motivational state, in which people react to situations, they feel their autonomy is threatened. This is the negative side of reactance, in which physicians want to reaffirm their freedom of choice and consciously or unconsciously either ignore the CDSS propositions or choose on purpose a different course of action. In this case, the quality of the resulting decision has deteriorated as compared to the system propositions. This negative side is balanced by the positive reactance, in which physicians do not follow the system propositions but built on them to refine and thus improve their decision according to the specific condition of the patient or to take into account the very last published evidence not yet integrated in the CDSS knowledge base. In the second scenario, we are in the case of the automation bias (AB) [16], i.e. the tendency to over-trust HIT leading a physician to make an incorrect decision in order to follow the advice provided by a CDSS [17]. Automation bias may be demonstrated by "negative consultation", a term used to denote when a correct decision is changed to an incorrect one on the basis of an incorrect advice. In a systematic review [18], negative consultations range from 6 to 11%.

The aim of this work is to analyze the intervention arm of the randomized controlled trial where OncoDoc2 had to be used for all breast cancer patients discussed during MDMs. In previous works with the same context, we studied the accuracy of actual data entry, and how the way OncoDoc2 was used had an impact on the quality of MDM decisions assessed by their compliance with CPGs [10]. In this paper, we study the attitude of MDM physicians towards the advice of OncoDoc2 in order to assess the part of reactance and automation bias when they finally make their decisions. This paper does neither discuss the methods nor present the results of the trial, which will be presented in a different paper.

Materials and Methods

The guideline-based CDSS OncoDoc2

OncoDoc2 [8] is a computerized guideline-based CDSS. It provides patient-specific recommendations for breast cancer patients according to CancerEst (local) CPGs. The system can be automatically run on patient data extracted from EHRs. It can also be used according to the document-based paradigm of decision-making where the knowledge base is interactively browsed by the user. In this case, using OncoDoc2 consists of answering, by a simple click on the right value, a sequence of closed-ended questions displayed in the interface to finally access the guideline-based advice of the system made of a set of recommended care plans. The user-controlled navigation through the knowledge base, noted N, instantiates criteria according to patient-specific data, and selects the theoretical clinical profile of the knowledge base that best fits the actual patient. Figure 1 shows a screenshot of OncoDoc2 displaying a navigation, characterized by the "Recapitulative", and the corresponding advices ("CancerEst Recommended Treatment Plans"). OncoDoc2 has been routinely used at the Tenon hospital (Paris, France) with a compliance rate of 91.7% [9].

Data collection

We have analyzed the data produced by the weekly organized MDMs of the three hospitals of the intervention arm of the randomized controlled trial. In each of the three hospitals, MDM physicians had to use OncoDoc2 for all breast cancer patients. For each decision, we automatically collected the navigation performed by MDM physicians N^{MDM}, the advices provided by OncoDoc2 $\{R\}^{CDSS}$, and the MDM decision d. Additionally each week, clinical research assistants (CRAs) collected the list of patient cases discussed in MDMs the previous week. For each of them, they ran OncoDoc2 and performed their own navigation on the basis of the information found in patient medical records, without knowing what were the navigations of MDM physicians for the same patients.

The two types of compliance

We considered that for each patient, the CRA-performed navigation was the "gold standard" named "reference navigation", denoted N^{Ref}, and that the advices of OncoDoc2 attached to the reference navigation represented the set of reference guideline-based recommendations that applied to the

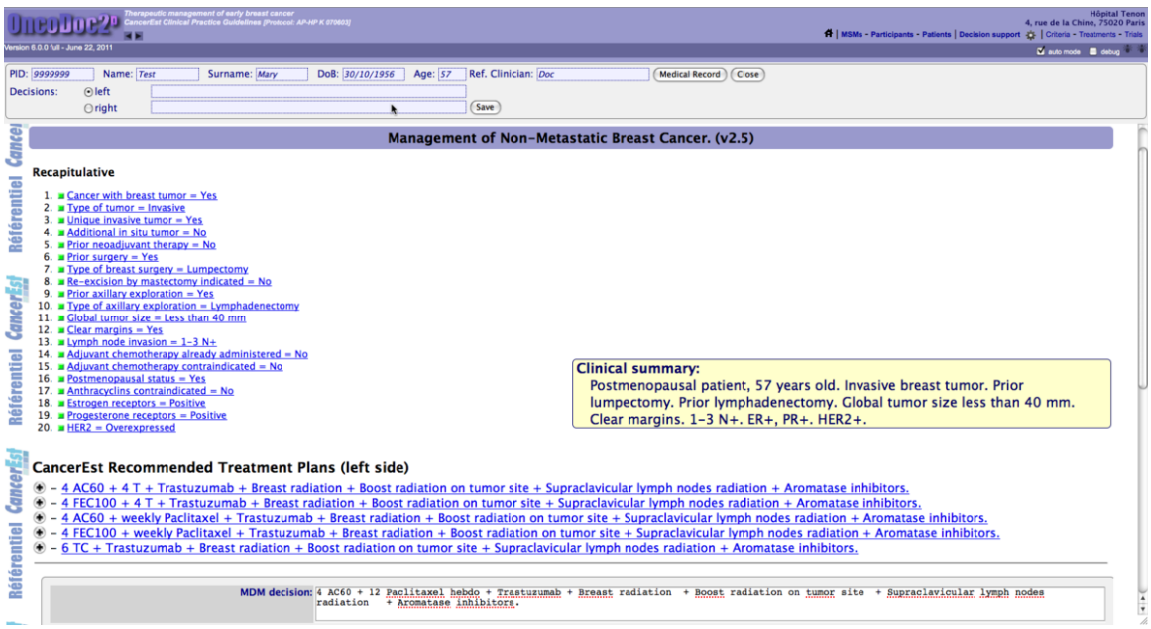

Figure 1 – A screenshot of OncoDoc2 providing advices as treatment plans for a given patient profile

patient, noted $\{R\}^{Ref}$. We stated that a MDM decision d complies with CPGs when $d \in \{R\}^{Ref}$, noted CPGs+.

When MDM physicians used OncoDoc2, and obtained the system advices $\{R\}^{CDSS}$, they could either follow one of the CDSS advices, or react and decide a different care plan. We state that a MDM decision d complies with OncoDoc2 when $d \in \{R\}^{CDSS}$, noted CDSS+.

Quality of the CDSS advice

As previously mentioned, misuses or errors when using CDSSs could lead to the delivery of non-CPG-compliant advices by the CDSS. In the context of OncoDoc2, errors in data input during the user-controlled navigation lead to situations in which $N^{MDM} \neq N^{Ref}$. Usually, in these situations, the set of advices provided by OncoDoc2, $\{R\}^{CDSS}$, does not correspond to the set of reference guideline-based recommendations $\{R\}^{Ref}$. However, it may happen that erroneous data entries lead to appropriate reference recommendations. When considering MDM decisions made with OncoDoc2, we distinguish three different situations:

- Advice+: $\{R\}^{CDSS} = \{R\}^{Ref}$. The CDSS proposes exactly the set of recommended care plans. This is systematically the case when the navigation N^{MDM} is correct, i.e. $N^{MDM} = N^{Ref}$, but can also be true when N^{MDM} is erroneous.
- Advice+/-: $\{R\}^{CDSS} \cap \{R\}^{Ref} \neq \emptyset$. The CDSS proposes at least one of the recommended care plans. N^{MDM} navigations are also necessarily erroneous.
- Advice-: $\{R\}^{CDSS} \cap \{R\}^{Ref} = \emptyset$. The CDSS proposes none of the recommended care plans. N^{MDM} navigations are necessarily erroneous.

Physicians' attitudes towards the CDSS advice

Considering the two types of compliance, CPGs+ and CDSS+, four different CDSS-supported decision-making attitudes, have to be considered. Notations are summarized in Table 1:

Table 1 – Summary of notations and categories of physicians' attitudes in CDSS-supported decision-making

CPGs+	Decision complies with CPGs
CPGs-	Decision does not comply with CPGs
CDSS+	Decision complies with CDSS
CDSS-	Decision does not comply with CDSS
Advice+	All CDSS propositions comply with CPGs
Advice+/-	At least one CDSS proposition complies with CPGs
Advice-	None of CDSS propositions comply with CPGs
Comp+	User follows CDSS and decision is CPG-compliant
React+	User does not follow CDSS and decision is CPG-compliant
Comp-	User follows CDSS and decision is not CPG-compliant
React-	User does not follow CDSS and decision is not CPG-compliant

- Comp+: CDSS+ $\wedge$ CPGs+. The user follows the CDSS advices and her decision adheres to CPGs, which corresponds to a positive compliance with the CDSS.
- React+: CDSS- $\wedge$ CPGs+. The user does not follow the advices of the CDSS, but her decision complies with CPGs. She reacts to the system to improve the final decision which corresponds to a positive reactance.
- Comp-: CDSS+ $\wedge$ CPGs-. The user follows the advices of the CDSS although they do not comply with CPGs. She does not have a critic attitude towards the system propositions and decides as proposed by the CDSS, which corresponds to a

negative compliance with the CDSS, also named automation bias.

- React-: CDSS- ∧ CPGs-. The user does not follow the advices of the CDSS and she does not decide according to CPGs. She reacts to the CDSS propositions to adopt a decision which does not comply with CPGs, which corresponds to a negative reactance.

Consolidation of the CDSS use and physicians' attitudes

We analysed the relationships between the type of advice delivered by OncoDoc2 and the type of physicians' attitudes depending on their compliance with CPGs and compliance with the CDSS. Figure 2 illustrates the possible configurations.

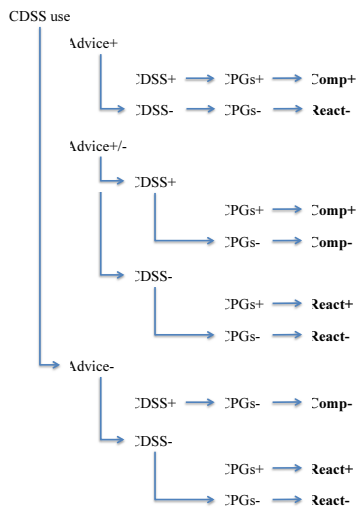

Figure 2 – Formalization of physicians' attitudes towards the CDSS depending on the type of the advice

Results

Data was collected for the intervention arm of the trial, including three hospitals, between June 2009 and April 2010. A total of 394 MDM decisions were made with the support of OncoDoc2 and considered for the analysis. The overall CDSS compliance rate was measured at 75.4%, showing a reactance rate of 24.6%. The overall CPG compliance rate was 86.8%.

As reported in [10], OncoDoc2 was incorrectly used in 52% of the cases. However, on the basis of the comparison with the recommendations of reference navigations, we observed that 68.8% of MDM decisions were made in Advice+ situations where all OncoDoc2's propositions were correct recommendations, and that 21.3% of MDM decisions were made in Advice- situations where all advices provided by OncoDoc2 were incorrect. Compliance with CPGs was significantly different according to the advice category (χ^2, $p < 10^{-9}$) and was measured at 65.5% for Advice-, whereas it was 92.3% for Advice+, and 94.9% for Advice+/-. In the same way, the CDSS compliance rate was significantly different according to the advice category (χ^2, $p < 10^{-37}$), and measured at 92.3%, 74.4%, and 21.4% for Advice+, Advice+/-, and Advice- respectively. Table 2 summarizes the distribution for the three advice categories and the associated CDSS and CPG compliances.

Table 2 – Distribution of advice categories and their corresponding CDSS and CPG compliances

Categories	n	(%)	CDSS+	CPGs+
Advice+	271	(68.8%)	92.3%	92.3%
Advice+/-	39	(9.9%)	74.4%	94.9%
Advice-	84	(21.3%)	21.4%	65.5%
Total	394	(100.0%)	75.4%	86.8%

The distribution of MDM physicians' attitudes towards OncoDoc2 is reported in Table 3. In 70.8% of the cases, the compliance with the CDSS advice was positive (Comp+), yielding CPG-compliant decisions. Reactance to the system advice represents nearly one quarter of all decisions (24.6%). Reactance is positive in about 2/3 of reacted decisions, leading to CPG-compliant decisions. Finally, the automation bias, or negative compliance with the system, is estimated at 4.6% of all MDM physician decisions. It must be noted that automation bias was observed only in the Advice- category.

Table 3 – Distribution of the four categories of MDM physicians' attitudes towards OncoDoc2 for decision-making

User attitudes	n	(%)
Comp+	279	(70.8%)
React+	63	(16.0%)
React-	34	(8.6%)
Comp-	18	(4,6%)
Total	394	(100%)

Discussion

OncoDoc2 was associated with a global CPG compliance of 86.8% and with a CDSS compliance of 75.4%. The expected effect of the CDSS, i.e. the positive compliance Comp+, when the 2 compliances simultaneously occur, was 70.8%.

More specifically, when CDSS advices include guideline-based recommendations (Advice+ and Advice+/-), CPG-compliance exceeds 92%. This suggests that the correct reminder of CPGs by a CDSS may foster their adoption. We observed that Advice- situations occurred in 21.3%. Such situations necessarily occur when the patient characterization in the system (N^{MDM} navigation) is not accurate. This proportion of situations where no guideline-based recommendation is provided by OncoDoc2 is important, but less than the 52% of erroneous navigations observed in [10]. In these cases, physician decisions to follow the erroneous OncoDoc2 advices in 21.4% of the cases, and compliance with CPGs falls to 65.5%. This illustrates the unintended consequences of CDSSs and serves as a reminder that the accuracy of collected data, as well as CDSS usability are fundamental issues to address. Further analysis should investigate the determinants of Advice- situations.

The risk of Advice- situations is to favor the automation bias, and the compliance with CDSS, in the detriment of the compliance with CPGs. With our dataset, and according to the proposed formalization of users' attitudes, automation bias was measured at 4.6% of the CDSS-supported decisions. This

is lower than the 6 to 11% rates reported by the review conducted by Goddard et al. [18].

In 16.0% of the cases, MDM physicians positively reacted (React+) to the system. This demonstrates that they critically considered inappropriate CDSS advices and that in these cases, physicians' knowledge of CPGs is strongly established. On the opposite, negative reactance (React-) occurred when CDSS advices were not adopted and the decision was not CPG-compliant. This suggests that either CPGs are not known, or are not trusted, or are not appropriate to the patient. Indeed, in some particular clinical situations, deviating from CPGs can be either necessary since recommendations may not apply. This highlights the limits of CPG-based care and the room for clinical expertise, as promoted by evidence-based medicine.

This study presents some limitations. First, the reference navigation were built from the data found in patient records and considered as the gold standard, but might not be the best characterization of the patient. Errors in the patient record could lead to erroneous reference navigation. Thus an erroneous reference navigation is compared to an accurate MDM navigation. Some data input by MDM physicians considered as erroneous compared to the reference could in fact come from their clinical interpretation. For instance, they may consider that a patient could not undergo a chemotherapy, while nothing in the patient record suggests it. In addition, when the reference navigation is correct, physicians may have good clinical reasons not to comply with the CDSS advices for the benefit of the patient. This occurs for instance in the case of particular patient characteristics like BRCA1 mutation, patient preferences, or evolutions of the state of the art, where the propositions of the CDSS are not the best up-to-date recommendations for the patient. Automation bias may also be hidden behind Comp+ situations, where users follow the CDSS advices, and comply to CPGs while it would be better for a particular patient to deviate from CPGs. The same could be observed in React- situations. For instance, in the case of a surgery by mastectomy and axillary dissection is recommended, CDSS advice is tumorectomy, and decision is mastectomy, then, the decision neither complies with the CDSS nor with CPGs and is classified as React-. However, if the surgical treatment is split into two different surgical steps, mammary and axillary surgeries, we observe that there is a positive reactance (React+), from the advised tumorectomy to the recommended mastectomy for the mammary surgery, and a negative compliance (Comp-), since no axillary treatment is advised or decided albeit recommended. As a conclusion, the effect of the CDSS on the decision-making process is more complex than our proposed formalization, especially for complex multiple-step decisions. But these effects are hardly quantifiable since not detectable.

Conclusion

This study demonstrates that, when wrongly used, a guideline-based CDSS could deliver non guideline-based advices that hinder compliance of decisions with CPGs and favors user attitudes like negative reactance and automation bias. Hopefully, the advantages of HIT could outweigh the disadvantages. In our study, global compliance with CPGs was improved in the intervention arm, when OncoDoc2 was used [10]. The challenge is now to foster CPG compliance while warrantying patient safety through correct use of CDSSs. Potential solutions include improving CDSS user interface, ensuring data quality, and training physician to both CDSS and CPGs while adopting a critical appraisal on CDSS output.

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