Crucial Factors for the Acceptance of a Computerized National Medication List

Insights into Findings from the Evaluation of the Austrian e-Medikation Pilot

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Summary
Objective: The objective of this paper is to present crucial factors among registered doctors and pharmacists for acceptance of the Austrian 'e-Medikation' system which is aimed at providing, on a national level, complete and recent information on all the medication that were prescribed or dispensed to a patient.
Methods: As the accompanying formative evaluation study of the pilot project showed different overall acceptance rates among participating physicians and pharmacists, a decision tree analysis of 30 standardized survey items was performed to identify crucial acceptance factors.
Results: For the physicians' group, only two items (fear of improper data use and satisfaction with software support) were crucial for overall e-Medikation acceptance. The analysis of the pharmacists' data resulted in five crucial factors primarily focusing on functional aspects and the perceived benefits of e-Medikation.
Conclusion: The results indicate that the acceptance among physicians and pharmacists depends on quite different factors. This must be taken into account during the planned rollout of e-Medikation or of comparable products.

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Introduction

Good medicine demands good information [1]. This is especially true for prescribing medication, which is a very complex and error-prone task [2]. Medication-related adverse events remain among the most frequently occurring adverse events and significantly endanger patient safety [3].

Unfortunately, as the medication cycle is a complex process involving numerous stakeholders in multiple health care institutions, complete medication information is often not available for the acting health care professional. A patient, for example, may visit different physicians of different specializations. Each one may prescribe a specific medication, often without having the full information on all the drugs their colleagues had prescribed before. In addition, patients may buy over-the-counter drugs (OTC), which potentially interact with the prescribed drugs. However, when neither physicians nor pharmacists have full medication information, medication treatment may be suboptimal or even harmful, as a patient could take dangerous combinations of different or over-dosed drugs.

Computerized physician order entry (CPOE) systems can help to reduce errors within the prescription phase [4]. In particular, advanced CPOE systems with integrated sophisticated decision support functions have the strongest potential to increase patient safety [5]. However, to unfold their full potential, such systems need access to all relevant clinical data and specifically to precise, recent, timely, and complete medication information. Therefore, sophisticated CPOE systems are more likely to be utilized in hospitals, where the information density is naturally higher and communication channels are less complex than in the primary care sector.

To respond to the special needs of the outpatient sector and to facilitate the transmural medication information exchange, the *Austrian e-Medikation system* was designed as a service of the national electronic health record (EHR) system ELGA [6], based on the Austrian e-Card network as the platform for unique patient identification and secure health data exchange [7]. The e-Medikation pilot project was intended to provide, on a national level, complete and up-to-date medication-related information for participating registered doctors, pharmacies, hospitals, and patients. This information comprised data on all prescription only drugs and on selected patient purchased OTC drugs that were prescribed and/or dispensed to a patient within the last six months. Additionally, the e-Medikation pilot system could run automated drug interaction checks on each new medication prescription or dispensing. The resulting interaction or duplication warnings could be displayed directly in the practice or pharmacy information systems, as e-Medikation clients had been integrated by the different software vendors. These clients were also used to transmit new prescription and dispensing information directly to a central e-Medikation database for storage. Subsequently, information could be retrieved electronically by other participating health care providers when they were visited by the same patient. The patients themselves could obtain their current e-Medikation information in printed form at any participating health care provider. Collecting data on every medication prescription and dispensing, the data in the e-Medikation system represents a national medication history. E-Medikation should not be confused with e-Prescribing, since all prescriptions are – and for the foreseeable future will remain – paper-based.

In 2011, a pilot project was set up to test and to evaluate the e-Medikation system in three regions: an urban area in Vienna, a rural region in Tyrol and a mixed, urban and rural, area in Upper Austria. The observational formative evaluation study comprised standardized surveys of participating physicians, pharmacists, hospital representatives (physicians, nurses, IT and administrative staff members), and patients as well as log-file analyses of the e-Medikation system. Overall, 92 physicians, 57 pharmacies (employing approximately 230 pharmacists), three hospitals (one in each pilot region), and more than 5,000 patients participated voluntarily in this pilot project. 61 physicians, 68 pharmacists, and 553 patients responded to the written surveys. Details concerning the e-Medikation system, the pilot project, and the overall evaluation study can be found at [8, 9]. A detailed evaluation report is available at [10].

The results showed that the basic concept of e-Medikation – establishing a complete and up-to-date patient medication list, providing the information to all involved health care professionals and institutions, and offering central medication safety checks – was highly appreciated among patients and pharmacists. By comparison, the acceptance among participating physicians was lower. The Austrian Chamber of Physicians strongly criticized e-Medikation, citing the alleged lack of benefits,

unclear risks, and high costs of the system. After intensive discussions and several critical media campaigns, the Austrian Chamber of Physicians even announced a formal boycott of the e-Medikation pilot project, which significantly decreased the system use from mid-July until September 2011. However, 35% of the responding physicians were still positive in their final opinion on e-Medikation and would have recommended participation in e-Medikation to their colleagues in the event of a national rollout (in contrast, the pharmacists' recommendation rate was 67.6%).

Given the different acceptance rates, the objective of this study was to identify and to investigate crucial factors for the acceptance of e-Medikation among pharmacists and physicians.

Methods

The evaluation study of the Austrian e-Medikation pilot in 2011 was conceived and conducted collaboratively by two teams of health informatics specialists from the Medical University of Vienna and the University of Health Sciences, Medical Informatics and Technology (UMIT) in Hall in Tirol. The overall evaluation study was approved by the Ethical Research Committee of UMIT.

The presented analysis of acceptance data focused on the results of the standardized user surveys that were conducted with all participants. The main objective of these physicians' and pharmacists' surveys was to determine the level of satisfaction with technical and organizational aspects of e-Medikation and the pilot project, to gain knowledge on usage, effort, and opportunities for improvement, and to collect their final opinion of e-Medikation.

Data Acquisition

The questionnaires for the physicians' and pharmacists' surveys were developed iteratively based on the items of UTAUT (Unified Theory of Acceptance and Use of Technology) [11], the DeLone and McLean Information Success Model [12], and existing e-prescription surveys [13, 14]. Feedback from physicians, pharmacists, and IT professionals as well as suggestions for survey items were collected during the design phases and included by consensus, taking into account survey length limitations. Pretests were conducted with two physicians and four pharmacists. The final questionnaires were almost identical for pharmacists and physicians. One item (A7) was only relevant for the pharmacists and thus omitted in the physicians' survey. Slight linguistic leveling was done in order to adapt the questions to the respective addressees (e.g. patient<->customer). The final questionnaires contained 30 standardized items (four-point and two-point Likert scales with 'No Answer' option) regarding the *pilot project* and *e-Medikation*, which were included in the analysis. ▶Figure 1 depicts a complete list of the 30 items.

The questionnaires as well as prepaid, addressed envelopes were distributed by mail to all participating pharmacists and physicians in December 2011.

Data Preprocessing and Data Analysis

The returned questionnaires were scanned and automatically analyzed using optical mark recognition software (Remark Office OMR® version 8.0). Manual data quality checks were performed by two independent researchers.

The answers to the four-point Likert scales were then dichotomized in two categories: The options 'Agree' and 'Partly agree' were combined into a positive category 'Agreement' and the options 'Partly disagree' and 'Disagree' were combined into a negative category 'Disagreement'. The 'No Answer' cases were kept as a third category. Omitted responses were treated as missing values.

First analyses were performed using descriptive statistics. The results were visualized in a 'heat map' like manner for a comparative overview of the responses of the different professional groups.

Then, in order to gain deeper insight into crucial factors for the acceptance or rejection of e-Medikation among physicians and pharmacists, a machine learning approach using decision tree analysis was applied. Item *B12 (Would you recommend your colleagues to participate in e-Medikation in case of a national rollout?)* was used as the dependent variable, as it best reflected the overall acceptance of e-Medikation among the participants. All other items were included in the analysis as

independent variables. Two separate trees were calculated for the two professional groups. In order to grow the trees, the CRT method (classification and regression trees) as provided by SPSS® (version 20, IBM Inc.) was used, as it produces trees with leaves that are as homogeneous as possible with respect to the dependent variable [15]. Ten-fold cross-validation [16] was used to validate the classifier.

Results

In total, 61 physicians (response rate 66%) and 68 pharmacists (response rate approx. 30%) returned a questionnaire. The response rate for the physicians can only be approximated as the exact number of employed pharmacists is not known.

The overall rate of omitted answers for the 30 standardized items was very low: 1.8% for the physicians and 0.5% for the pharmacists. One physician survey in which the dependent variable was missing (item *B12* omitted) was excluded from the analysis. The rate of cases in which respondents were undecided or didn't declare their opinion on one of the 30 items was low at 5.5% for the physicians and 6.1% for the pharmacists. These cases were included in the analysis, as the respondents had explicitly ticked the 'No Answer' option.

The two professional groups showed similar response patterns, with pharmacists generally being more positive than the physicians (▶ Figure 1). Concerning the overall acceptance of e-Medikation (item *B12*, highlighted in bold in ▶ Figure 1), 35% of the physicians' opinions were positive, 18.3% declared no opinion, and 46.7% were negative. Among the pharmacists' responses, 67.6% were positive, 7.4% were undecided, and 25% were negative.

The decision tree analysis revealed that for the different professional groups, varying factors were crucial regarding the overall acceptance or rejection of e-Medikation. For the physicians, only two items, *B6 (Do you fear that data stored in e-Medikation may be used improperly?)* and *A8 (Are you satisfied with the support by your software vendor during the pilot project?)*, were selected in the final validated classification tree (▶ Figure 2*)*:

78.9% of the physicians, who did not fear that data stored in e-Medikation could be used improperly (disagreement with item *B6*, n = 19) felt positively about e-Medikation. Among the remaining 41 physicians who had concerns regarding data misuse (agreement with item *B6*) or did not declare an opinion (no answer to item *B6*), the acceptance of e-Medikation was significantly lower at 14.6% (n = 6). The rejection rate of e-Medikation among these 41 physicians was 63.4% (n = 26). 22% (n = 9) gave no opinion.

All 15 physicians, who feared that data might be used improperly (*B6*) and who were not satisfied with the support of their practice information system software vendor (*A8*) disliked e-Medikation. The other 26 physicians' opinions were negative in only 42.3% of the cases (23.1% agreement, 34.6% no answer). Thus, with a combination of just these two items (*B6, A8*), a classification performance of 71.4% for acceptance and 92.9% for rejection could be achieved (see *the bottom of* ▶ Figure 2).

The analysis of the pharmacists' data determined five crucial factors (▶ Figure 3): *B10d (Do you feel that, in the future, all dispensings of OTC drugs should be entered into the e-Medikation system and made available to authorized physicians and pharmacists?), B8 (Do you feel that e-Medikation, if implemented nationwide, would give you a better overview on all medications of your patients?), B10a (Do you feel that, in the future, all prescriptions of prescription-only drugs (POM) should be entered into...?), B7 (Do you fear that e-Medikation may lead to limitation of your professional autonomy?) and B2 (Do you have the impression that patients who participate in e-Medikation show better compliance regarding their drug therapy?)* With these five factors a classification performance of 93.5% for acceptance and 70.6% for rejection could be achieved.

While in general 67.6% of the responding pharmacists were pro e-Medikation, acceptance rose to 73% among those pharmacists voting for or being neutral concerning the inclusion of OTC dispensing (*B10d*), to 78.6% for those pharmacists also feeling that e-Medikation would give a better overview (*B8*), to 84.3% for those who additionally supported *B10a* (inclusion of POM prescriptions), and to 90.2% for the pharmacists who also had no concerns on limitations of professional autonomy due to e-Medikation (*B7*). Finally, those pharmacists who did not disagree with item *B2* (better com-

pliance among e-Medikation patients) showed a recommendation rate of 96.4% for e-Medikation (27 out of 28).

Discussion

The results of the current study correlate with a number of similar studies regarding trans-institutional information systems and/or IT-based information exchange. It is notable that many more surveys of physicians [17–20] than surveys of pharmacists [21] on this topic exist. Their results, e.g. from the US [19] or Korea [20], show that in other countries physicians are concerned with information security and privacy as well when health information exchange is established. Similar concerns could be found in a study where the acceptance of an EHR among physicians in Austria was investigated [22]. The top five negative statements in the ranking of [22] also included data privacy and data protection concerns (rank 2), as well as the unauthorized use of EHR data (rank 4). A recent study on the acceptance of EHRs in primary care settings showed that support and documentation, as well as the software itself, are important factors for acceptance [23], which is the second most important factor among physicians in this study.

In general, pharmacists seem to be less concerned with these issues and more focused on the expected benefits [24] similar to the results in this study. Klapf et al. [25] developed an acceptance model for e-Health Solutions which illustrates that technological factors have a major influence on the acceptance of e-Health Solutions. Other important factors in this model are the perceived usefulness as well as the trustworthiness of the solution's information. This model also illustrates that the majority of the elements of the TAM (Technology Acceptance Model) questionnaire [26] are relevant in the field of e-Health. This was supported by other studies, such as [27]. A comprehensive review of the requirements regarding EHRs is presented in [28], where the categories with the most requirements identified (apart from global requirements and specific functionality) are data security, contents, and usability of EHRs.

Due to the studied sample population (voluntary participation in the e-Medikation pilot and actual number of participants in the evaluation study resulting in selection bias) as well as specific attributes of the prototype system and pilot project, the findings may not be easily generalizable to other countries or settings. In addition, the choice and parameterization of the machine learning algorithm (e.g. tree growing method or node size) may have an influence on the resulting model. Nonetheless, the identified factors have been confirmed by other e-Health acceptance studies. To our knowledge, our survey is the first that directly compares and contrasts the attitudes of two very important professional groups regarding medication-related IT use – pharmacists and physicians.

Clinical Relevance

The results of this study are of particular importance in the context of the implementation of a future e-Medikation system or comparable applications, as they indicate that the group of health care professionals can be quite heterogeneous and different factors for acceptance or rejection may exist in different subgroups. Therefore, it is crucial to carefully analyze project-specific requirements in general as well as to consider the specific requirements and concerns of the different subgroups within the 'health care professionals' stakeholder group. Although this seems obvious, this important step is often neglected in practice, which can significantly influence the subgroup's perception of the whole project and its goals.

Conflict of Interest

The authors declare that they have no conflicts of interest in the research.

Human Subjects Protections

The procedures used have been reviewed in compliance with ethical standards of the responsible committee on human experimentation.
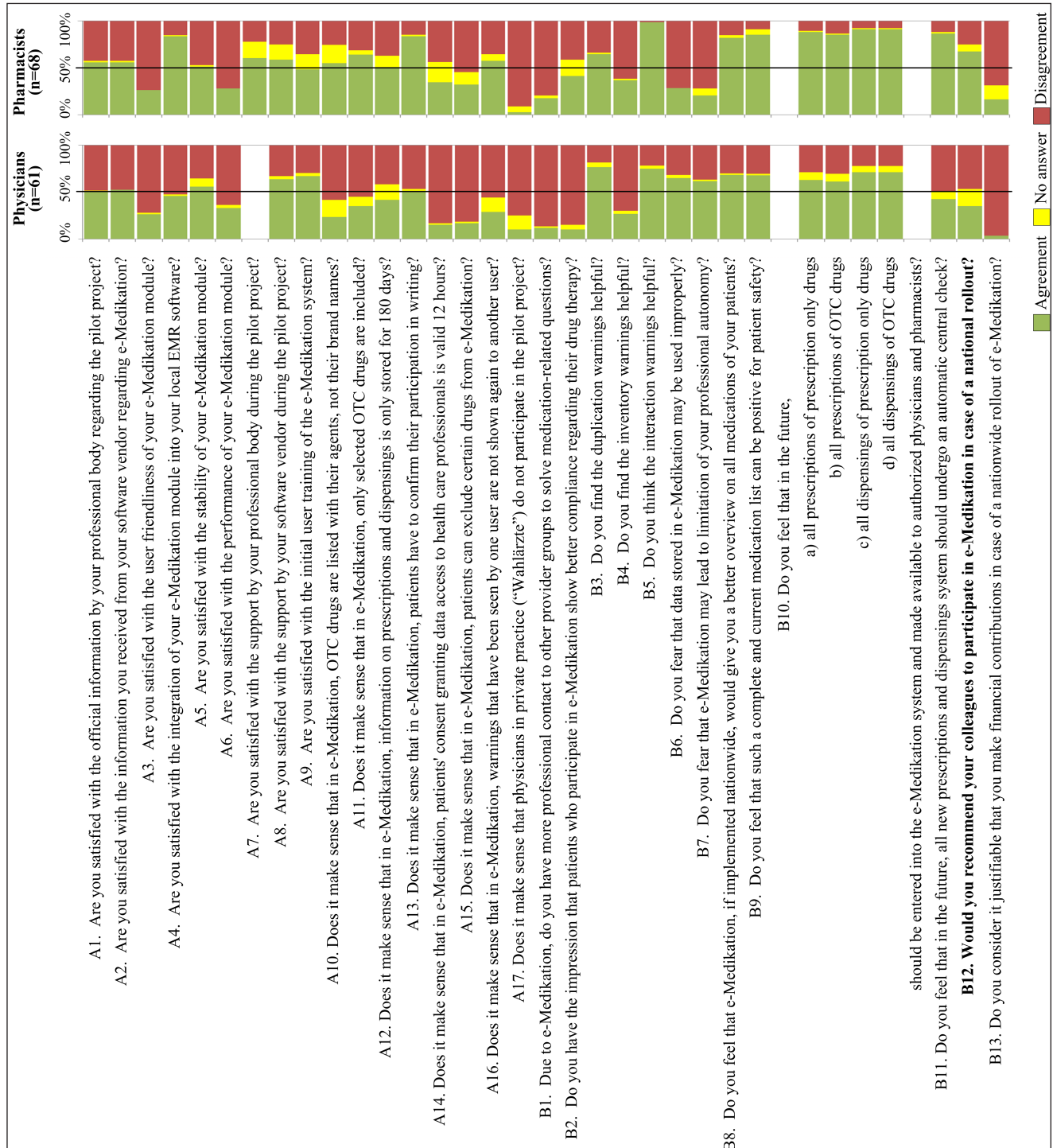
Fig. 1 Comparative overview on physicians' and pharmacists' responses to the 30 items.

The chart displays responses from Physicians (n=61) and Pharmacists (n=68) across the following items:

A1. Are you satisfied with the official information by your professional body regarding the pilot project?
A2. Are you satisfied with the information you received from your software vendor regarding e-Medikation?
A3. Are you satisfied with the user friendliness of your e-Medikation module?
A4. Are you satisfied with the integration of your e-Medikation module into your local EMR software?
A5. Are you satisfied with the stability of your e-Medikation module?
A6. Are you satisfied with the performance of your e-Medikation module?
A7. Are you satisfied with the support by your professional body during the pilot project?
A8. Are you satisfied with the support by your software vendor during the pilot project?
A9. Are you satisfied with the initial user training of the e-Medikation system?
A10. Does it make sense that in e-Medikation, OTC drugs are listed with their agents, not their brand names?
A11. Does it make sense that in e-Medikation, only selected OTC drugs are included?
A12. Does it make sense that in e-Medikation, information on prescriptions and dispensings is only stored for 180 days?
A13. Does it make sense that in e-Medikation, patients have to confirm their participation in writing?
A14. Does it make sense that in e-Medikation, patients' consent granting data access to health care professionals is valid 12 hours?
A15. Does it make sense that in e-Medikation, patients can exclude certain drugs from e-Medikation?
A16. Does it make sense that in e-Medikation, warnings that have been seen by one user are not shown again to another user?
A17. Does it make sense that physicians in private practice ("Wahlärzte") do not participate in the pilot project?
B1. Due to e-Medikation, do you have more professional contact to other provider groups to solve medication-related questions?
B2. Do you have the impression that patients who participate in e-Medikation show better compliance regarding their drug therapy?
B3. Do you find the duplication warnings helpful?
B4. Do you find the inventory warnings helpful?
B5. Do you think the interaction warnings helpful?
B6. Do you fear that data stored in e-Medikation may be used improperly?
B7. Do you fear that e-Medikation may lead to limitation of your professional autonomy?
B8. Do you feel that e-Medikation, if implemented nationwide, would give you a better overview on all medications of your patients?
B9. Do you feel that such a complete and current medication list can be positive for patient safety?
B10. Do you feel that in the future,
  a) all prescriptions of prescription only drugs
  b) all prescriptions of OTC drugs
  c) all dispensings of prescription only drugs
  d) all dispensings of OTC drugs
  should be entered into the e-Medikation system and made available to authorized physicians and pharmacists?
B11. Do you feel that in the future, all new prescriptions and dispensings system should undergo an automatic central check?
B12. Would you recommend your colleagues to participate in e-Medikation in case of a national rollout?
B13. Do you consider it justifiable that you make financial contributions in case of a nationwide rollout of e-Medikation?

Legend: **Agreement** (green) · **No answer** (yellow) · **Disagreement** (red)

Physicians (n=60)

Would you recommend your colleagues to participate in e-Medikation in case of a national rollout?

Overall Agreement

Node 0		
Category	%	n
■ Disagreement	46,7	28
■ Agreement	35,0	21
□ No Answer	18,3	11
Total	**100,0**	**60**

B6. Do you fear that data stored in e-Medikation may be used improperly?

Disagreement

Agreement; No Answer

Node 1		
Category	%	n
■ Disagreement	10,5	2
■ Agreement	78,9	15
□ No Answer	10,5	2
Total	**31,7**	**19**

Node 2		
Category	%	n
■ Disagreement	63,4	26
■ Agreement	14,6	6
□ No Answer	22,0	9
Total	**68,3**	**41**

A8. Are you satisfied with the support by your software vendor during the pilot project?

Disagreement

Agreement; No Answer

Node 3		
Category	%	n
■ Disagreement	100,0	15
■ Agreement	0,0	0
□ No Answer	0,0	0
Total	**25,0**	**15**

Node 4		
Category	%	n
■ Disagreement	42,3	11
■ Agreement	23,1	6
□ No Answer	34,6	9
Total	**43,3**	**26**

Classification Performance

	Predicted			
Observed	Disagreement	Agreement	No Answer	Percent Correct
Disagreement	26	2	0	92,9%
Agreement	6	15	0	71,4%
No Answer	9	2	0	0,0%
Overall Percentage	68,3%	31,7%	0,0%	68,3%

Fig. 2   Results of the machine learning approach using ten-fold cross-validated decision tree for determining crucial factors for e-Medikation acceptance or rejection among physicians (n = 60). The trees are read from top to bottom. In each leaf, the distribution of answer categories for item *B12* ("Would you recommend your colleagues to participate in e-Medikation in case of a national rollout"), which was declared as the dependent variable, is shown in relative and absolute numbers. The predicted category for *B12* is highlighted in gray in each leaf. Classification performance is shown at the bottom.

Pharmacists (n=68)

Would you recommend your colleagues to participate in e-Medikation in case of a national rollout?

Overall Agreement

Node 0

Category	%	n
■ Disagreement	25,0	17
■ Agreement	67,6	46
■ No Answer	7,4	5
Total	**100,0**	**68**

B10d. Do you feel that in the future, all dispensings of OTC drugs should be entered into the e-Medikation system and made available to authorized physicians and pharmacists?

Disagreement

Node 1

Category	%	n
■ Disagreement	100,0	5
■ Agreement	0,0	0
■ No Answer	0,0	0
Total	**7,4**	**5**

Agreement; No Answer

Node 2

Category	%	n
■ Disagreement	19,0	12
■ Agreement	73,0	46
■ No Answer	7,9	5
Total	**92,6**	**63**

B8. Do you feel that e-Medikation, if implemented nationwide, would give you a better overview on all medications of your patients?

Agreement; No Answer

Node 3

Category	%	n
■ Disagreement	14,3	8
■ Agreement	78,6	44
■ No Answer	7,1	4
Total	**82,4**	**56**

Disagreement

Node 4

Category	%	n
■ Disagreement	57,1	4
■ Agreement	28,6	2
■ No Answer	14,3	1
Total	**10,3**	**7**

B10a. Do you feel that in the future, all prescriptions of prescription only drugs should be entered into thee-Medikation system and made available to authorized physicians and pharmacists?

Agreement

Node 5

Category	%	n
■ Disagreement	9,8	5
■ Agreement	84,3	43
■ No Answer	5,9	3
Total	**75,0**	**51**

Disagreement; No Answer

Node 6

Category	%	n
■ Disagreement	60,0	3
■ Agreement	20,0	1
■ No Answer	20,0	1
Total	**7,4**	**5**

B7. Do you fear that e-Medikation may lead to limitation of your professional autonomy?

Agreement; No Answer

Node 7

Category	%	n
■ Disagreement	20,0	2
■ Agreement	60,0	6
■ No Answer	20,0	2
Total	**14,7**	**10**

Disagreement

Node 8

Category	%	n
■ Disagreement	7,3	3
■ Agreement	90,2	37
■ No Answer	2,4	1
Total	**60,3**	**41**

B2. Do you have the impression that patients who participate in e-Medikation show better compliance regarding their drug therapy?

Disagreement

Node 9

Category	%	n
■ Disagreement	23,1	3
■ Agreement	76,9	10
■ No Answer	0,0	0
Total	**19,1**	**13**

Agreement; No Answer

Node 10

Category	%	n
■ Disagreement	0	0
■ Agreement	96,4	27
■ No Answer	3,6	1
Total	**41,2**	**28**

Classification Performance

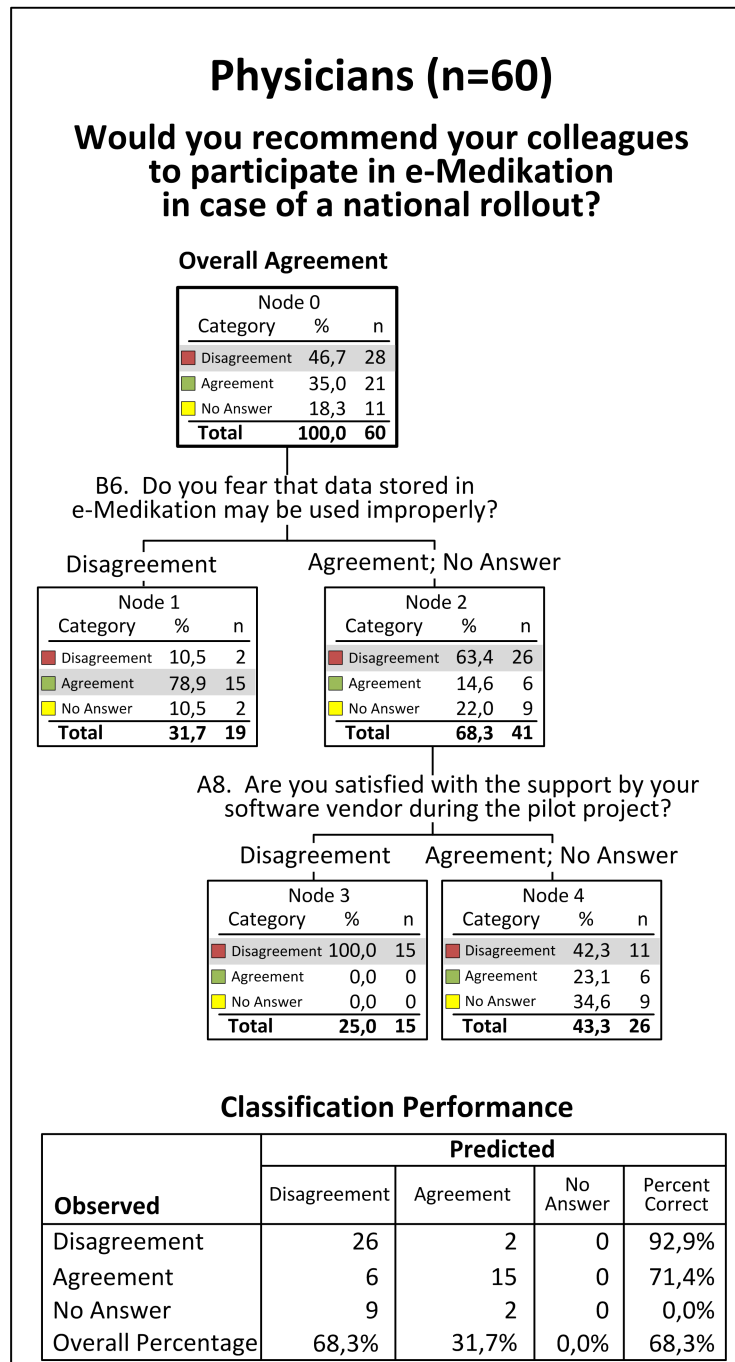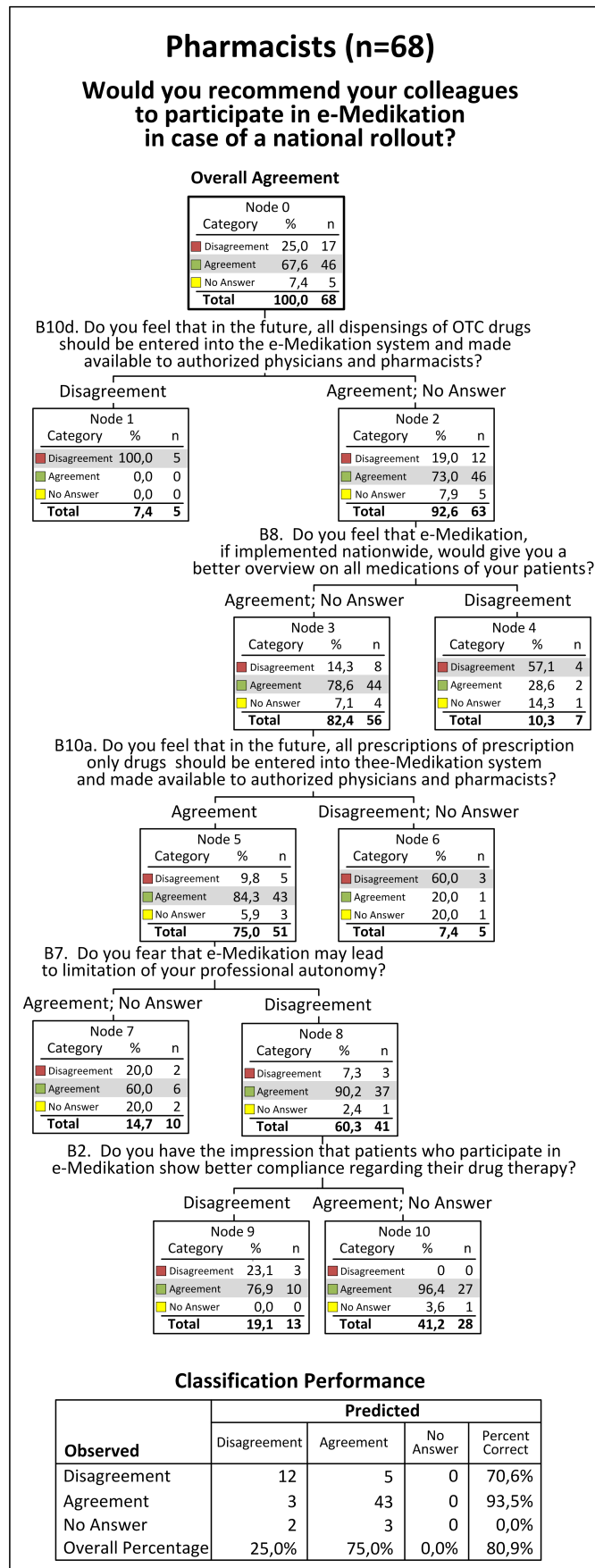|	Predicted			
Observed	Disagreement	Agreement	No Answer	Percent Correct
Disagreement	12	5	0	70,6%
Agreement	3	43	0	93,5%
No Answer	2	3	0	0,0%
Overall Percentage	25,0%	75,0%	0,0%	80,9%

Fig. 3 Results of the machine learning approach using ten-fold cross-validated decision tree for determining crucial factors for e-Medikation acceptance or rejection among pharmacists (n = 68). The trees are read from top to bottom. In each leaf, the distribution of answer categories for item *B12* ("Would you recommend your colleagues to participate in e-Medikation in case of a national rollout"), which was declared as the dependent variable, is shown in relative and absolute numbers. The predicted category for *B12* is highlighted in gray in each leaf. Classification performance is shown at the bottom.

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