Turk J Gastroenterol 2007; 18 (3): 157-164

Evaluation of the Turkish translation of the Minimal Standard Terminology for Digestive Endoscopy by development of an endoscopic information system

Gastrointestinal Endoskopi için Minimal Standart Terminoloji'nin bir endoskopik enformasyon sistemi geliştirilerek değerlendirilmesi

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Background/aims: *There are very few evaluation studies for the Minimal Standard Terminology for Digestive Endoscopy. This study aims to evaluate the usage of the Turkish translation of Minimal Standard Terminology by developing an endoscopic information system.* ***Methods:*** *After elicitation of requirements, database modeling and software development were performed. Minimal Standard Terminology driven forms were designed for rapid data entry. The endoscopic report was rapidly created by applying basic Turkish syntax and grammar rules. Entering free text and also editing of final report were possible. After three years of live usage, data analysis was performed and results were evaluated.* ***Results:*** *The system has been used for reporting of all endoscopic examinations. 15,638 valid records were analyzed, including 11,381 esophagogastroduodenoscopies, 2,616 colonoscopies, 1,079 rectoscopies and 562 endoscopic retrograde cholangiopancreatographies. In accordance with other previous validation studies, the overall usage of Minimal Standard Terminology terms was very high: 85% for examination characteristics, 94% for endoscopic findings and 94% for endoscopic diagnoses. Some new terms, attributes and allowed values were also added for better clinical coverage.* ***Conclusions:*** *Minimal Standard Terminology has been shown to cover a high proportion of routine endoscopy reports. Good user acceptance proves that both the terms and structure of Minimal Standard Terminology were consistent with usual clinical thinking. However, future work on Minimal Standard Terminology is mandatory for better coverage of endoscopic retrograde cholangiopancreatographies examinations. Technically new software development methodologies have to be sought for lowering cost of development and the maintenance phase. They should also address integration and interoperability of disparate information systems.*

Key words: MST, terminology, endoscopy, information system, computer, software, database

Amaç: *Gastrointestinal Endoskopi için Minimal Standart Terminoloji ile ilgili az sayıda değerlendirme çalışması bulunmaktadır. Bu çalışmada amaç Minimal Standart Terminoloji Türkçe tercümesinin bir endoskopik enformasyon sistemi geliştirilerek değerlendirilmesidir.* ***Yöntem:*** *Gereksinim analizi yapıldıktan sonra veritabanı modellemesi ve yazılım geliştirme işlemleri gerçekleştirildi. Hızlı veri girişi için Minimal Standart Terminoloji tabanlı formlar tasarlandı. Endoskopi raporu daha sonra temel Türkçe imla ve yazım kuralları kullanılarak oluşturuldu. Serbest metin girişi ve son raporun düzenlenmesi mümkündü. Üç yıllık canlı kullanım sonrası veri analizi gerçekleştirilerek sonuçlar değerlendirildi.* ***Bulgular:*** *Sistem tüm endoskopik işlemlerin raporlanması amacıyla kullanıldı. 15,638 geçerli kayıt incelendiğinde 11,381 adet üst gastrointestinal endoskopi, 2,616 kolonoskopi, 1,079 rektoskopi ile 562 endoskopik retrograt kolanjiyopankreatografi tespit edildi. Önceki diğer değerlendirme çalışmalarında olduğu gibi Minimal Standart Terminoloji terimlerinin genel kullanımı oldukça yüksekti: İncelemenin özellikleri %85, endoskopik bulgular %94 ve endoskopik tanılar yine %94 olarak izlendi. Ayrıca daha geniş klinik kullanım amacıyla Minimal Standart Terminoloji'ye bazı yeni terimler, özellikler ve değerler eklendi.* ***Sonuç:*** *Minimal Standart Terminoloji rutin endoskopi raporlarının büyük bir oranını kapsamıştır. Kullanıcıların sistemi iyi kabullenmeleri Minimal Standart Terminoloji terimlerinin ve yapısının genel klinik düşünce ile uyum içerisinde olduğunun ispatıdır. Endoskopik retrograt kolanjiyopankreatografi işlemlerinin daha iyi kapsanması amacıyla gelecekte bir çalışma zorunlu gözükmektedir. Teknik açıdan da yazılım geliştirme ve idame maliyetlerinin düşürülebilmesi amacıyla yeni yöntemler aranmalıdır. Bu yöntemler ayrıca farklı enformasyon sistemlerinin entegrasyonu ve birlikte çalışabilirliğine çözüm getirmelidir.*

Anahtar kelimeler: MST, terminoloji, endoskopi, enformasyon sistemi, bilgisayar, yazılım, veritabanı

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Manuscript received: 29.12.2006 **Accepted:** 09.08.2007

INTRODUCTION

A substantial amount of work has been done for more than a decade in the design and development of endoscopic databases and application software (1-11). Such systems not only have great potential to contribute advantages such as better quality and safety in endoscopy and increased productivity due to automated data entry and report generation, but also aid in clinical research and education by recording complete and accurate data. It has been reported repeatedly in studies that structured reports are superior to free-text reports in endoscopy as they offer a built-in quality control into the report by specifying the terms to be used together with their attributes and values unambiguously (11-17). Existence of clinical terminologies and health informatics standards are essential elements for development of health information systems. Most computerized systems emerged after the introduction of the World Organisation of Digestive Endoscopy (OMED) terminology (18,19) and subsequent publication of the Minimal Standard Terminology (MST) for Digestive Endoscopy (20-22). The first version of MST was first validated retrospectively (23) and then prospectively by large multi-center studies in both Europe and the United States. The coverage of the terminology in describing endoscopic examinations was extremely high (24). The experience gained has led to revisions and a second version of MST was published (22). It is also translated into 11 languages (English, French, Italian, German, Portuguese, Spanish, Russian, Hungarian, Czech, Turkish and Japanese). More recently, as a proof of the universal acceptance of this terminology, MST has been integrated with the National Library of Medicine's Unified Medical Language System (UMLS) and also represented in the SNOMED-DICOM microglossary (25-28). They are crucial for linking of endoscopic information to scientific literature and reference image databases.

Despite all these standardization efforts and the widespread interest in using a common terminology for endoscopy, progress has been slow for penetration into routine clinical practice. Hence, only a very few studies have either evaluated or used the second version of MST (29-31).

MST was translated into Turkish by the Turkish Society of Gastroenterology in 1999. A computerized system was needed to use and evaluate it. In this study, we briefly describe technical details of the endoscopic information system (EIS) and then explain our evaluation methodology. The evaluation results will be presented with our proposed extensions to MST after three years of live clinical usage. To our knowledge, this study is among the first evaluation studies of MST in the literature having a relatively large number of cases.

MATERIALS AND METHODS

Two endoscopic workstations (Compaq EVO: Intel Pentium 4-1.6 GHz CPU, 128 MB RAM, 20 GB disc capacity) running on Microsoft Windows 98 operating system and a color laser printer (HP Color LaserJet 4550) were used in the study. The routine backups were done with a CD recorder.

Microsoft Access 2000 was used for relational data modeling and storage. The primary database Table (B) contained fields for patient demographics (name, surname, sex, age and origin), clinical information (hepatitis/HIV markers and disease status), examination information (examination type, endoscopic device, premedication and date), coded and free text endoscopic diagnoses, and other information such as the referring department, endoscopists' codes, sign-out history and image status. MST-based database tables were linked with one-to-one relationship to the primary database Table B by using the unique examination number. These tables were: KOLON, ÖMD1, ÖMD2, ÖMD3 (Findings data for colon, esophagus, stomach, and duodenum, respectively), endoscopic retrograde cholangiopancreatography (ERCP) (Findings data for biliary system and pancreas), GENEL12 (Examination characteristics, reasons for examination, and complications data for upper and lower gastrointestinal endoscopy), GENEL3 (Examination characteristics, reasons for examination and complications data for ERCP), and EK (additional diagnostic and therapeutic procedures data).

The original hierarchy of MST, Class→Term→Attribute→Attribute value→Site(s)→ Intervention (Personal communication with MST Editor Dr. Louis Korman on 13.05.2004) was extended so as to produce a more consistent and user-friendly graphical user interface (GUI), which is presented side by side with the original MST hierarchy in Figure 1. In our implementation, "Site(s)" - the information about location of a particular lesion - was not directly linked to MST "Attribute value" but to "Term", because from an informatics point of view, "Term" was the real-world entity that could have "Site(s)" information, not attribute values or attributes.

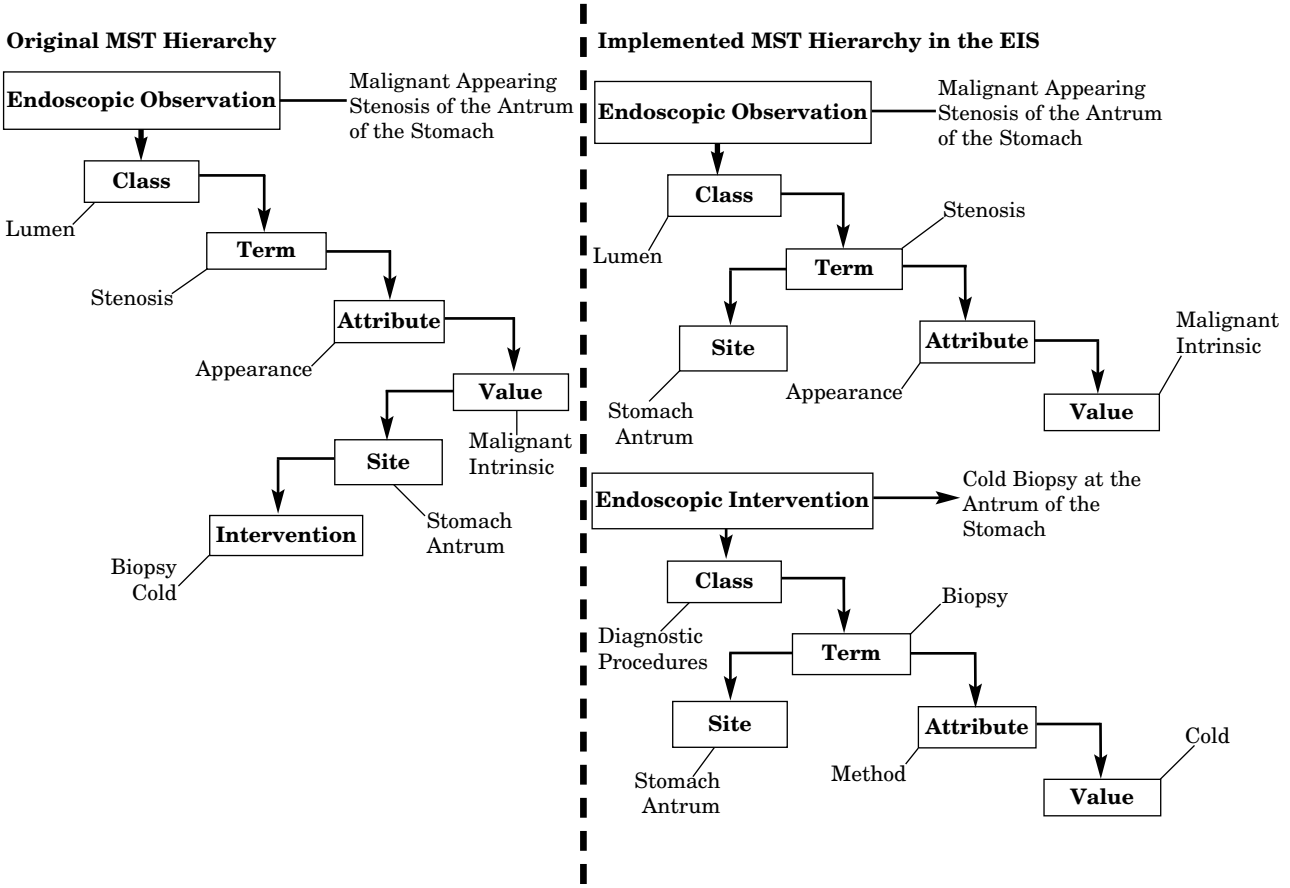

Figure 1. Original MST hierarchy and the extended EIS hierarchy

As an extension to MST, the single colonoscopy examination type was split into colonoscopy and rectoscopy, because endoscopists felt the need to differentiate between them even though the very same MST-based data tables and forms were used for both. The EIS was developed using Microsoft Visual Basic 6.0. Each workstation was stand-alone with its own local copy of the database and EIS installed. While designing the structured data entry (SDE) forms, primary concern was user-friendliness and simplicity because many prior studies gave clear indication of these key success factors for acceptability of computers and software by clinicians (1, 3, 6, 7, 9, 10). We aimed for reduced time and effort during data entry. During automatic report generation, the structured data collected by SDE forms and data from free-text blocks were merged and formed a valid endoscopic report. In this process, basic grammatical and syntactic rules of the Turkish language were employed, such as capitalization of the first letters of words following a dot or usage of appropriate suffixes after certain words. Screenshot of a MST-based SDE form (which was originally in Turkish but translated into English for comprehension in this manuscript) is given in Figure 2 to show the mapping of MST hierarchy onto EIS forms.

Before data analysis, the data in the two separate workstations were checked for consistency and some erroneous records with duplicates or null entries were discarded (i.e. only examination numbers were assigned but remaining fields were empty). The data from the two workstations were merged and consolidated into a single data file. For data analysis, Structured Query Language (SQL) statements were created using Microsoft Access 2000. For example, to determine whether MST-based diagnostic terms had been used, corresponding field values were checked as to whether they were greater than zero, the default value for a newly added record. For determination of usage of free text in fields allowing both free-text and MST terms, their values were checked as to whether they were null or empty (i.e. deleted later on). The discrimination between the missing values (null) and the zero values (empty or deleted) was thus accomplished.

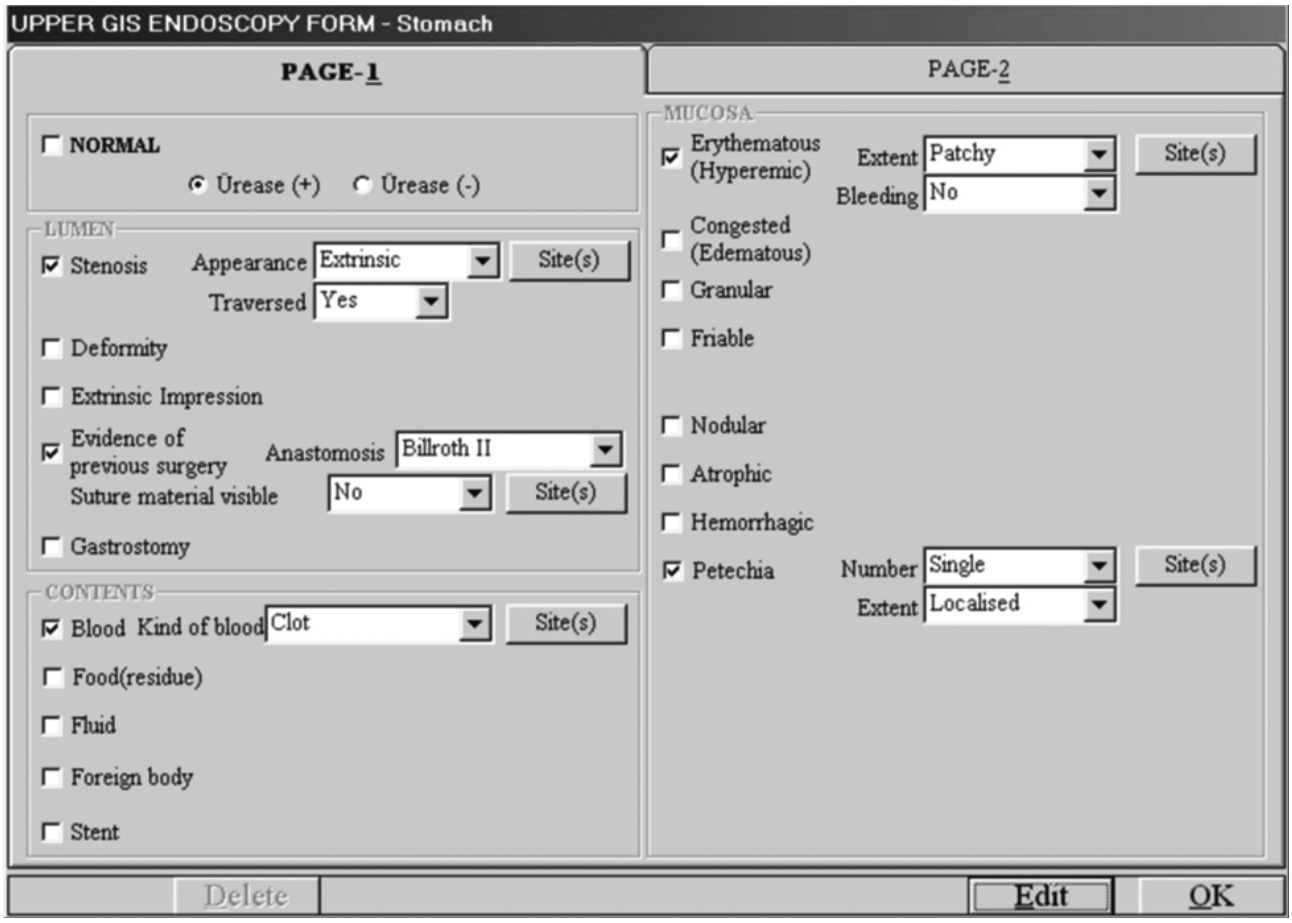

Figure 2. Screenshot of the MST-based form for entry of the findings for stomach during EGD examination

RESULTS

Data Analysis

Since June 2000, the total number of records in the two workstations was 15,777, with a data file size of 21 megabytes as of August 25, 2003. There was no selection bias and after data cleaning, we analyzed 15,638 records that were officially signed out and printed as valid endoscopy reports. There was no down-time of the systems during this period.

General distribution of records according to examination type was as follows: 11,381 (72%) esophagogastroduodenoscopy (EGD), 2,616 (17%) colonoscopy, 1,079 (7%) rectoscopy, and 562 (4%) ERCP. Overall usage of MST for recording examination characteristics (extent and limitation) was 85% (13,322 of 15,638 records). When we look at each examination type, 10,277 of 11,381 (90%) EGD, 2,369 of 2,616 (91%) colonoscopy, 624 of 1,079 (58%) rectoscopy and 52 of 562 (9%) ERCP records had at least one MST-based entry for examination characteristics. Reasons for endoscopy were recorded using MST terms in a total of 346 (2.21%) records. Their distribution according to examination type was: 261 of 11,381 (2.29%) EGD, 61 of 2,616 (2.33%) colonoscopy, 5 of 1,079 (0.46%) rectoscopy and 19 of 562 (3.38%) ERCP records. These usage data were determined by building SQL queries joining primary database Table B with GENEL12 and GENEL3. After running queries, records having non-null entries were calculated for each examination type.

The usage of MST terms for description of endoscopic findings is given in Table 1. We had determined the usage by counting the number of valid entries in database tables that were linked to the primary database Table B. Therefore, the number of records of a particular examination type in the primary database Table B may be different than (equal or greater) the number of entries recorded in the related SDE database tables due to records with no MST entries.

Table 1. Overall and detailed usage of MST terms for recording of endoscopic findings by examination type and organ

Exam Type and Organ	Total No. of Exams	MST Usage
EGD-Total	11381	11216 (98.55%)
EGD-Esophagus		11210 (98.50%)
EGD-Stomach		11199 (98.40%)
EGD-Duodenum		11167 (98.12%)
Colonoscopy-Colon	2616	2471 (94.46%)
Rectoscopy-Colon	1079	751 (69.60%)
ERCP-Total	562	258 (45.91%)
ERCP-Duodenum		242 (43.06%)
ERCP-Other Organs		250 (44.48%)
Overall usage	15638	14696 (93.98%)

Table 2. Comparative overall usage of MST terms and free text fields for recording of endoscopic diagnoses

No. of Exams	MST Terms (+)	MST Terms (-)	Sub Totals
Free Text (+)	4788 (30.62%)	719 (4.60%)	5507 (35.22%)
Free Text (-)	9911 (63.38%)	220 (1.40%)	10131 (64.78%)
Sub Totals	14699 (94.00%)	939 (6.00%)	15638(100.00%)

Free Text (+/-): Free text was used for diagnosis or not, MST Terms (+/-): At least one MST term was used or not

The comparative usage of MST terms and free text for recording of endoscopic diagnoses is given in Table 2. The usage was determined by analyzing both the fields containing enumerated MST diagnostic terms and also free text fields for each record. Further data analysis on MST diagnoses is given in Table 3, including the frequency of normal cases and top three diagnoses by examination type and organ. Presentation of these results follows the same structure of the publication of European Union framework project GASTER (24).

Overall usage of MST terms for additional diagnostic and therapeutic procedures was 19% (2,953 of 15,638 records). For each examination type, the figures were as follows: 2,489 of 11,381 (22%) EGD, 315 of 2,616 (12%) colonoscopy, 62 of 1,079 (6%) rectoscopy and 87 of 562 (15%) ERCP records. These usage data were determined by calculating the number of records with non-null entries by building SQL queries joining primary database Table B and database Table EK.

Table 3. Frequency of the use of MST diagnostic terms by examination type and organ

Exam Type and Organ	MST Diagnosis	No. of entries	% of entries	% of exams
	Normal	6840	57.45	43.74
EGD-Esophagus	Reflux esophagitis	2222	18.66	14.21
(Total terms: 11905)	Hiatus hernia	997	8.37	6.38
	Hypotonic LES*	996	8.37	6.37
	Normal	525	3.70	3.36
EGD-Stomach	Antral superficial gastritis*	2871	20.25	18.36
(Total terms: 14177)	Erythematous (hyperemic) gastropathy	2383	16.81	15.24
	Pangastritis*	1842	12.99	11.78
	Normal	6182	51.85	39.53
EGD-Duodenum	Bulbitis*	2642	22.16	16.89
(Total terms: 11924)	Duodenal ulcer	992	8.32	6.34
	Erosive duodenopathy	634	5.32	4.05
	Normal	539	19.06	3.45
Colonoscopy-Colon	Hemorrhoids	838	29.63	5.36
(Total terms: 2828)	Polyp	496	17.54	3.17
	Diverticulosis	322	11.39	2.06
	Normal	51	4.45	0.33
Rectoscopy-Colon	Hemorrhoids	828	72.25	5.29
(Total terms: 1146)	Anal fissure*	211	18.41	1.35
	Fistula	17	1.48	0.11
ERCP-Duodenum	Normal	1	100.00	0.01
	[Normal: cholangiography, post-sphincterectomy, post-cholecystectomy]	[69,9,2]	19.90	0.51
ERCP-Biliary System	Choledocholithiasis	165	41.04	1.06
(Total terms: 402)	Cholelithiasis	59	14.68	0.38
	Bile leak	13	3.23	0.08
	Normal	150	89.82	0.96
ERCP-Pancreas	Chronic pancreatitis	8	4.79	0.05
(Total terms: 167)	[Pancreatic tumor, failed pancreaticogram]	3	1.80	0.02
	Pancreas divisum	2	1.20	0.01
Total MST Diagnoses	42550			

*Newly added diagnostic term during the study

Table 4. Extensions to MST

Table No.	Organ	Site			
Table 2	Colon	***Anal canal***			
	Headings	**Terms**	**Attributes**	**Attribute values**	**Site (s)**
Table 6	Lumen	Lower esophageal sphincter	Tone	***-normal***	
	Protruding lesions	Tumor/Mass	Type	***-ulcero-vegetan***	
Table 7		***Rapid Urease Test***	***Result***	***-positive*** ***-negative***	
Table 9	Lumen	Evidence of previous surgery	Type	***-ileo-anal pouch*** ***-colo-rectal anastomosis***	
	Flat lesions	Angiectasia			***Site (s)***
	Protruding lesions	Hemorrhoids	**Type**	***-internal*** ***-external***	
			Grade	***-grade I through IV***	
Table 14	Therapeutic procedures	Thermal therapy	Device	***-heat-probe***	
Table 18	Diseases		**-sclerosing cholangitis** **-biliary fistulas**		
Table 19	Main diagnoses Other diagnoses		**-ectopic gastric mucosa** **-hypotonic lower esophageal sphincter**		
Table 20	Main diagnoses		**-pangastritis** **-antral superficial gastropathy** **-alkaline reflux gastropathy**		
Table 21	Main diagnoses Other diagnoses		**-bulbitis** **-bulbus deformity** **-stenosis**		
Table 22	Main diagnoses		**-anal fissure** **-stricture**		
	Other diagnoses		**-suspicion of flat adenoma** **-perianal abscess**		

There were 7,476 (48%) female subjects versus 6,163 (39%) male subjects; 1,999 (13%) records had null values in sex field. Numbers of records for some fields with missing values were: 1,522 (10%) age, 1,383 (9%) premedication details and 15,161 (97%) patient origin.

Extensions to MST

After initial installation, EIS then evolved by implementing new features and extensions to MST. This resulted in a better clinical coverage and more efficient data entry in SDE forms. These extensions are shown with bold and italic text in Table 4 with original MST table references as they appear in the original publication (22).

DISCUSSION

To our knowledge, this is among the first evaluation studies of the second version of MST. We believe that high coverage rate of the Turkish translation of MST for reporting endoscopic examinations in a university hospital endoscopy unit is a strong point for the validation of the terminology. It is important to note that the high usage rate of MST-based SDE forms purely resulted from user acceptance, as there was no obligation to complete any field and it was possible to write free text in the final report. Some sort of software control measures (i.e. warnings, compulsory fields) may be applied in future versions because the high rate of missing values in fields like age, sex, patient origin, clinical information and so on may diminish data quality, which might be crucial in clinical research. However, in this study, these missing data were recorded in the central hospital information system. This may be an explanation for the high number of missing values. Likewise, "Reasons for endoscopy" were also recorded at extremely low rates. This might be due to organizational preferences and problems with EIS. Examination of free text entries for endoscopic diagnoses revealed that they were mostly used for additional notes regarding the technical aspects of the study or success of the procedure, which should normally have appeared elsewhere in the report. There were also high numbers of repeating diagnoses like

"hypotonic lower esophageal sphincter (LES)" which were later added to the pick list. However, it is evident that further work on MST is needed for ERCP for better coverage, since usage was quite low compared to other examination types, and this is in line with previous studies (22).

Normal cases were relatively few, especially in EGD examinations. We believe there may be three contributing reasons: 1) Prevalence of *H. pylori* in Turkey is believed to be very high, which decreases the number of "normal" reports, 2) Endoscopists prefer to not give too many normal reports (false-positives are better), and 3) Definition of "normal" and "not normal" in clinical medicine is not completely clear. As another factor, diagnosis of duodenum was not routinely included in ERCP reports at the unit; a MST-based diagnostic term (Normal) was selected for the duodenum in only 1 out of 562 ERCP studies.

A major weakness of EIS was its inability to allow selection of a MST term with a different set of attributes or attribute values more than once. For example, if the endoscopist observed two different kinds of polyps in the colon, each having different attributes and possibly site data, it was only possible to record one. This was one of the major reasons for free-text editing of the final report. However, in MST, it is not stated explicitly whether a term or its attribute(s) are mandatory (existence), how many attributes terms can contain (cardinality) and the number of times they can occur (occurrence). Therefore, we strongly suggest incorporating this knowledge into future versions of MST to eliminate ambiguity.

From the technical point of view, the classical design principles used in this study, in which the domain knowledge in MST was "hard-coded" into the program code and database schema, proved to be successful in the study. Redesign, coding and testing were necessary each time a change in MST was needed, which entailed expense of considerable time and effort. It is evident that adaptive and future-proof software systems are needed to keep up with ever-changing requirements and medical knowledge (32).

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