

Linking Medical Records to an Expert System

Frank Naeymi-Rad Ph.D.¹, David Trace M.D.¹, and Fabio De Souza Almeida M.D.²

¹University of Health Sciences/The Chicago Medical School, North Chicago, Illinois 60064, (708) 578-3212

²Santa Clara Kaiser Medical Center, Department of Medicine, Santa Clara, California 95051

This presentation will be done using the IMR-Entry (Intelligent Medical Record Entry) system. IMR-Entry is a software program developed as a front-end to our diagnostic consultant software MEDAS (Medical Emergency Decision Assistance System).

MEDAS (the Medical Emergency Diagnostic Assistance System) is a diagnostic consultant system using a multimembership Bayesian design for its inference engine and relational database technology for its knowledge base maintenance. Research on MEDAS began at the University of Southern California and the Institute of Critical Care in the mid 1970's with support from NASA and NSF. The MEDAS project moved to Chicago in 1982; its current progress is due to collaboration between Illinois Institute of Technology, The Chicago Medical School, Lake Forest College and NASA at KSC. We acknowledge the support provided by Dr. Daniel Woodard, Dr. Paul Buchanan and Dr. Ronald White.

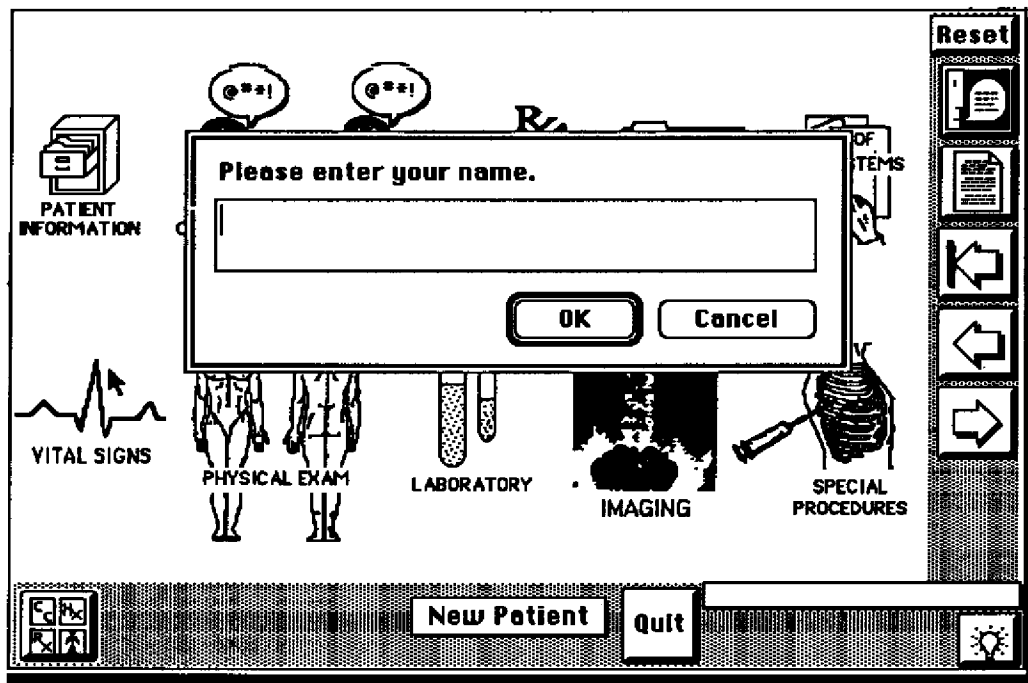
MEDAS DISORDER PATTERN

Dec. 01, 1988 8:45:36 AM		<<DISORDER PATTERN SYSTEM>> Developed by UHS/CMS Computer Center				Screen No. MED S20	
Disorder #12 (OR STOP)		Name: PULMONARY THROMBOEMBOLISM Category: RESPIRATORY Date Created: 02/13/87 Prevalence Rate: 0.07				# OFF: 75 SORT ID: Post+	
	<u>F#</u>	<u>Feature Name</u>	<u>P</u>	<u>Pbar</u>	<u>Post. When +</u>	<u>Post When -</u>	
1)	738	V/P LUNG SCAN: MMATCH VENT & (+) IPG	.949	.050	.588	.004	
2)	622	ANGIO: PULMONARY PERFUSION DEFECT	.899	.050	.575	.008	
3)	750	ECG - S1-Q3-T3 PATTERN	.100	.009	.455	.064	
4)	643	CXR: PULMONARY INFILTRATE UNILATERAL	.200	.029	.342	.058	
5)	174	S/O DEEP VEIN THROMBOPHLEBITIS	.300	.100	.184	.055	
6)	338	M.S. DEEP MUSCULAR TENDERNESS	.300	.100	.184	.055	
7)	485	PVS PITTING EDEMA UNILATERAL	.300	.100	.184	.055	
8)	630	V/P LUNG SCAN: EMBOLISM	.600	.200	.184	.036	
9)	747	H/O DEEP VEIN THROMBOSIS	.300	.100	.184	.055	
10)	638	CXR: ATELECTASIS	.050	.019	.165	.068	
11)	1179	CXR PLEURAL EFFUSION UNILATERAL	.300	.119	.159	.056	
1) Look 2) Create 3) Delete 4) Change prob 5) Sort option 6) Exit							
Please select 1, 2, 3, 4, 5, or 6 >							

This screen demonstrates the disorder pattern for Pulmonary Thromboembolism. Since the purpose of an expert system is to derive a hypothesis, its communication vocabulary is limited to features used by its knowledge base. Recognizing this problem our team in Chicago, for the last five years, has been working on the development of a comprehensive problem based medical record entry system which could handshake with an expert system while creating an electronic medical record at the same time.

IMR-E is a computer based patient record that serves as a "front end" to the expert system MEDAS. IMR-E is a graphically oriented comprehensive medical record. We demonstrate the program's major components in the following article:

IMR-Entry requires the provider to identify themselves before he or she is allowed to use the system. This Identification is used to tag all of the data created for the given session by the entry person's identification.



The following screen will appear by clicking on the Patient Information icon:




Patient Identification

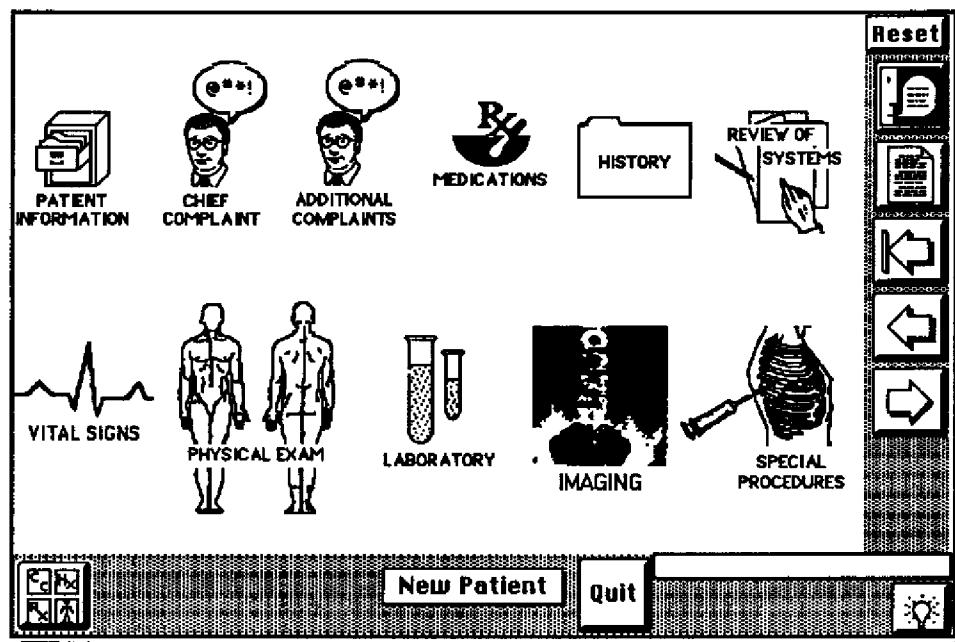
Last Name	First Name	
<div style="border: 1px solid black; padding: 2px;">Naeymi-Rad</div>	<div style="border: 1px solid black; padding: 2px;">Frank</div>	
Social Security #	Birthdate	Age
<div style="border: 1px solid black; padding: 2px;">1111-44-3333</div>	<div style="border: 1px solid black; padding: 2px;">10/10/50</div>	<div style="border: 1px solid black; padding: 2px;">51</div>
Sex	Race	Status
<div style="border: 1px solid black; padding: 2px;"> <u>male</u> female </div>	<div style="border: 1px solid black; padding: 2px;"> <u>white</u> black hispanic asian </div>	<div style="border: 1px solid black; padding: 2px;"> single <u>married</u> divorced widowed </div>

Quit

Quit

The patient selection screen can be integrated with any in-place demographics screen to eliminate the duplication of entry.

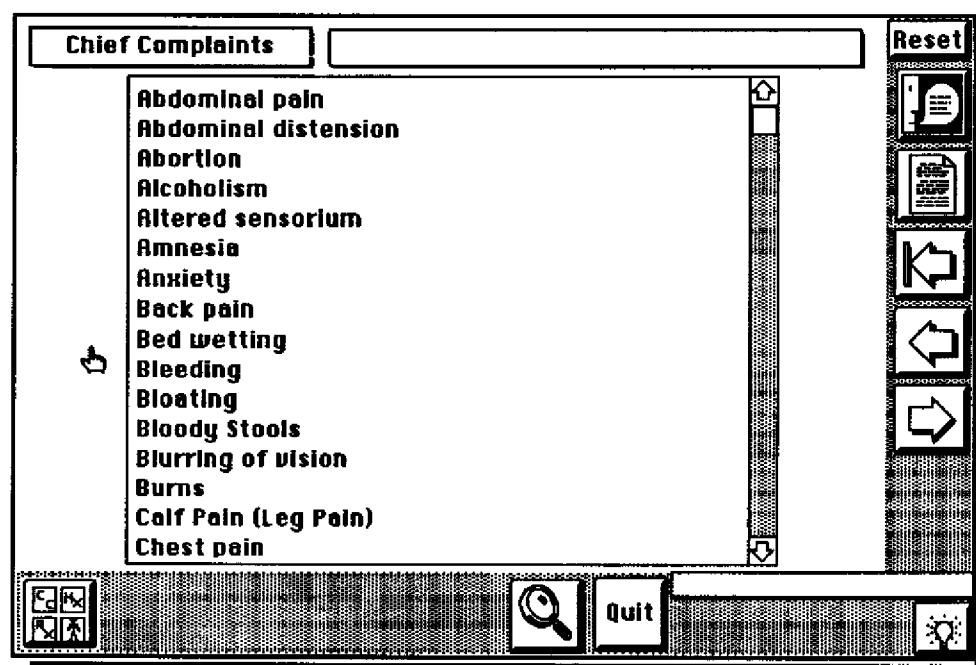
By clicking on the icon  the user will return to the following screen.



As you can see this is comprehensive and covers all of the sections for the physician's entry. The navigational icons were designed to aid the physician at each step of entry.





By clicking on the icon , the following screen appears:



There are 95 complete complaint programs. Each program allows the physician to custom create a paragraph for a given complaint by using the computer mouse. Each program manages between 20 to 50 objects which are displayed on 3 to 5 screens.

This is the first screen for Abdominal Pain Chief Complaint. We can select the appropriate options by simply clicking on them.

By clicking on the  we get the second screen for Abdominal Pain.

We can review text generated to this point by clicking on the icon .

Abdominal Pain	
Aggravated By nothing meals (1/2 to 1 hour after eating) meals (2 to 4 hours after eating)	Relieved By <u>nothing</u> antacids eating
<p>The onset of the abdominal pain has been sudden and has been occurring for 12 hours. The pattern of the abdominal pain has been persistent. It's course has been increasing. The abdominal pain is located in the right lower quadrant with radiation to the left flank and left lower quadrant. It is aggravated by coughing, standing and walking while relief is obtained by nothing. The abdominal pain is characterized as sharp and stabbing. The severity of the</p> <p>colicky a dull ache a pressure sensation</p> <p>Previous Evaluations barium enema upper gastrointestinal X-ray proctoscopy</p> <p>OK</p>	

Reset

Review


Back

Forward

Home

Help

Lightbulb

The last screen for this complaint will appear by clicking on the icon .

Abdominal Pain	
Associated With chest pain constipation dark urine diarrhea dysuria <u>fever</u> heartburn hematemesis hematuria jaundice melena <u>nausea</u> passing worms pica use of alcohol	Not Associated With abdominal distension amenorrhea anorexia bloating bloody stools bone pain bulky stools chest pain constipation dark urine diarrhea dysuria fever heartburn hematemesis

Reset

Review

Back

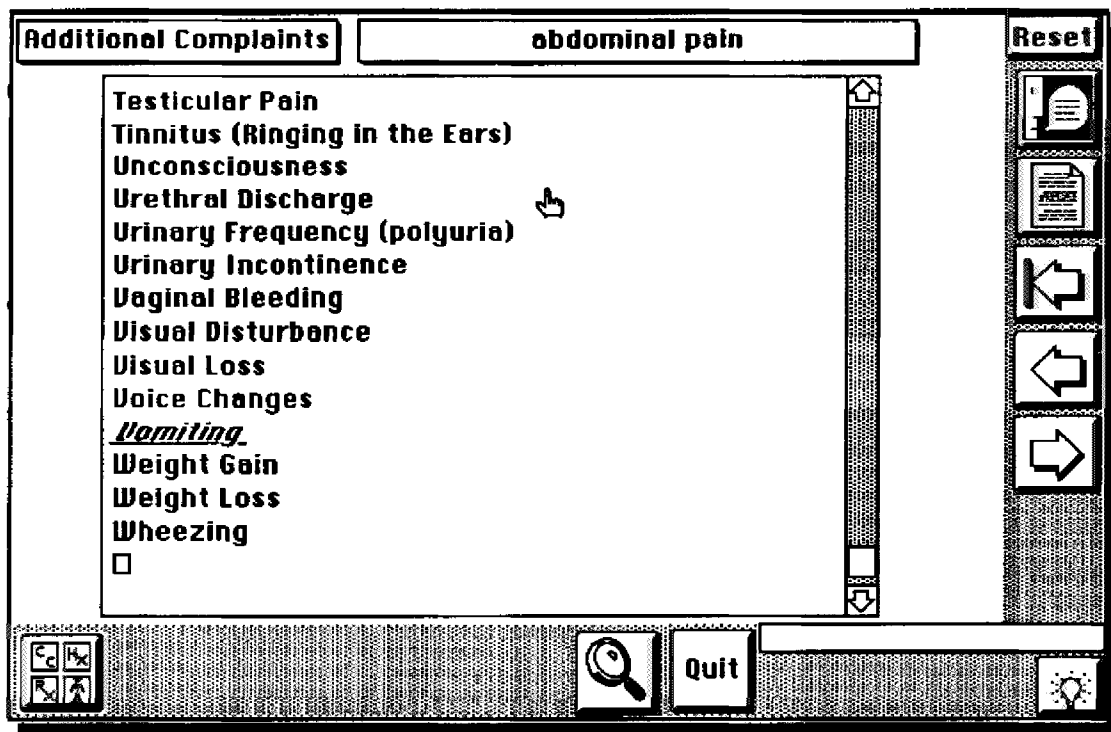
Forward

Home

Help

Lightbulb

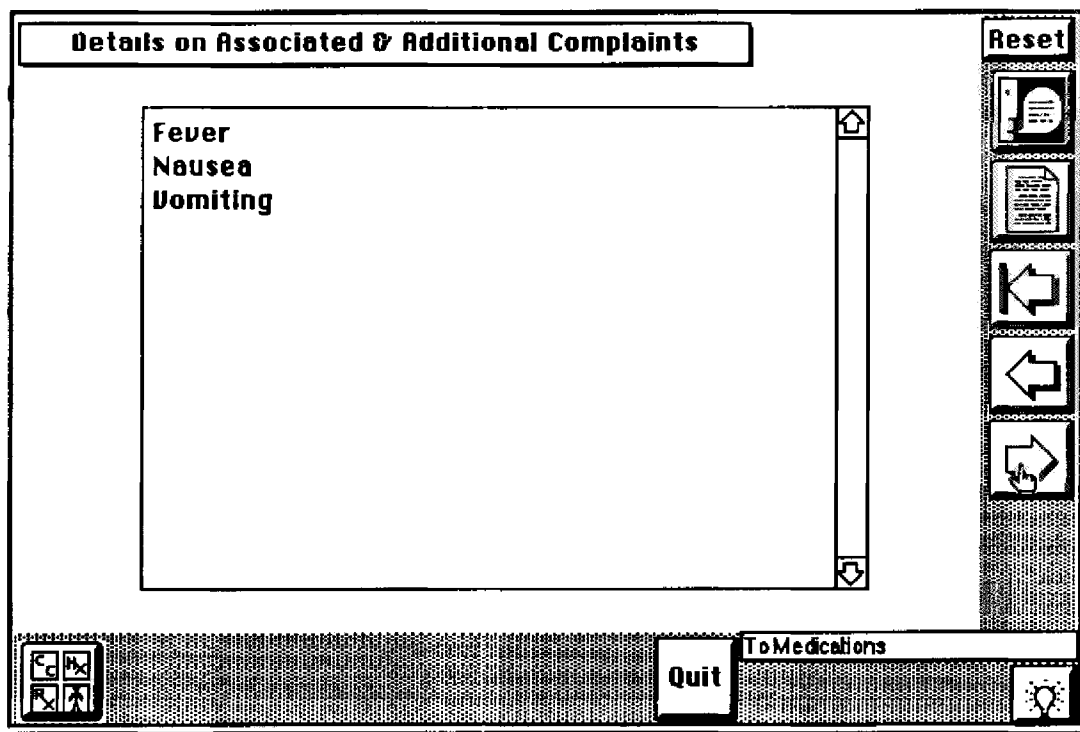
When we continue clicking on the  we move to the Additional Complaints Screen.



Additional Complaints abdominal pain **Reset**

- Testicular Pain
- Tinnitus (Ringing in the Ears)
- Unconsciousness
- Urethral Discharge
- Urinary Frequency (polyuria)
- Urinary Incontinence
- Vaginal Bleeding
- Visual Disturbance
- Visual Loss
- Voice Changes
- Vomiting
- Weight Gain
- Weight Loss
- Wheezing
- ☐

Quit



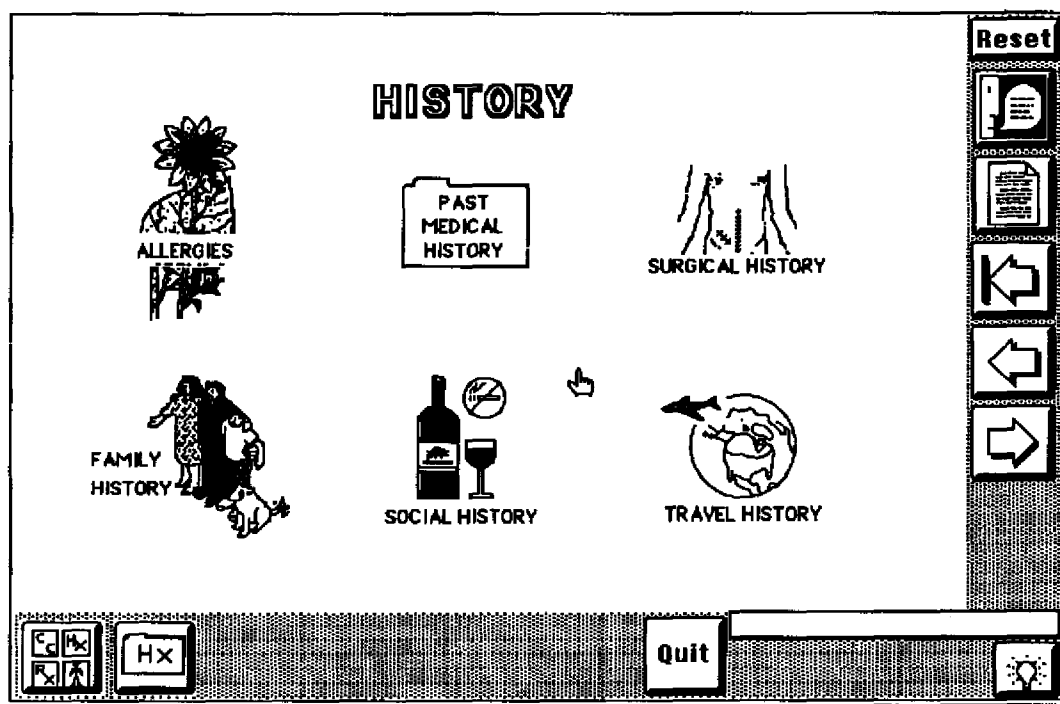
Details on Associated & Additional Complaints **Reset**

- Fever
- Nausea
- Vomiting

Quit **To Medications**

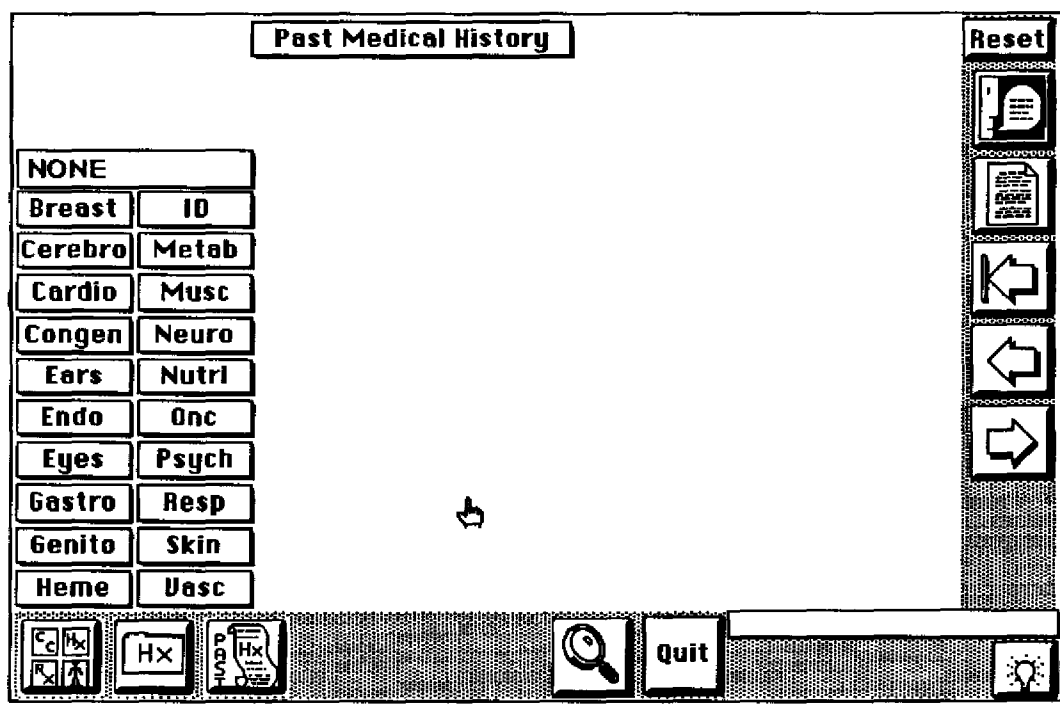
After selecting additional complaints, the system displays all the appropriate complaints that it has programmed for you. We could describe these complaints in more detail.


By selecting HISTORY folder  we can enter all of the history information.




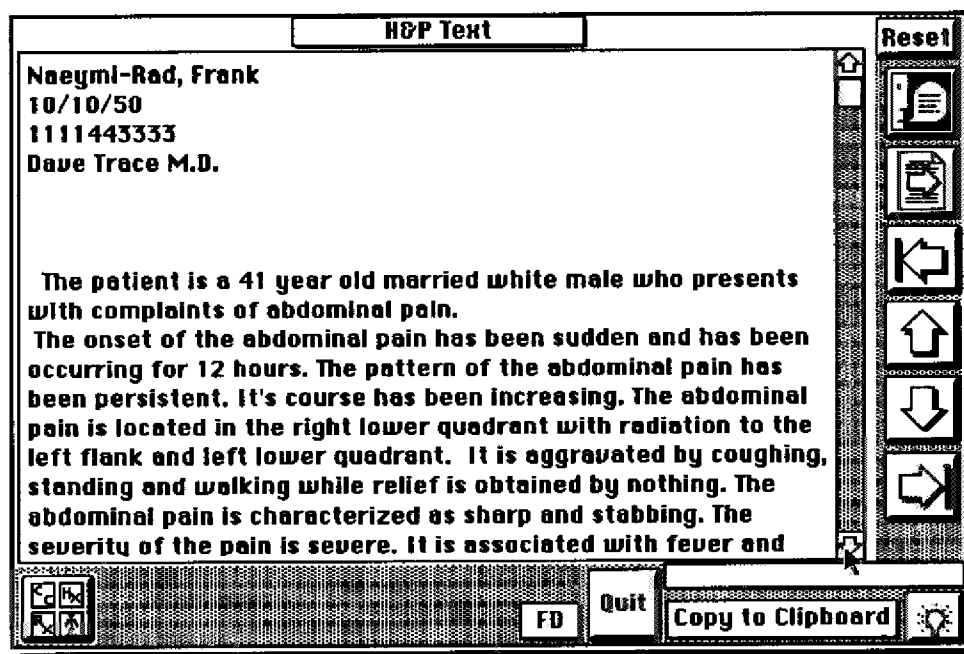
We must note that the Travel History is incomplete since does not include space travel history.

By selecting the PAST MEDICAL HISTORY Folder  we get to the next screen.




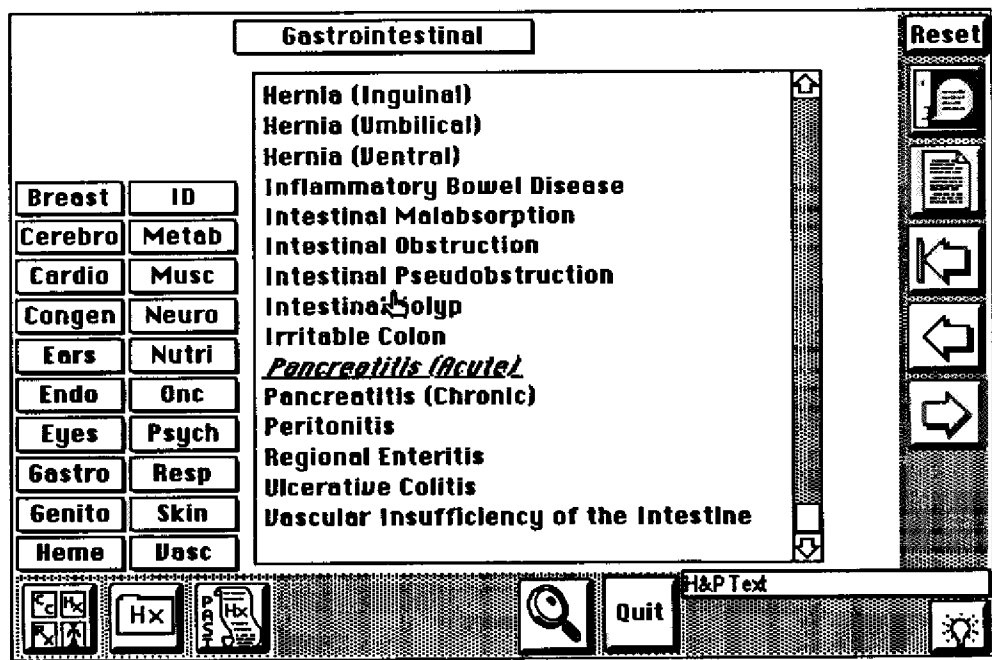
Please note: as the mouse  moves over the Icons, the dialog window on the lower right displays the function of the icon.


By clicking the text  icon system displays the current status of the final electronic report.

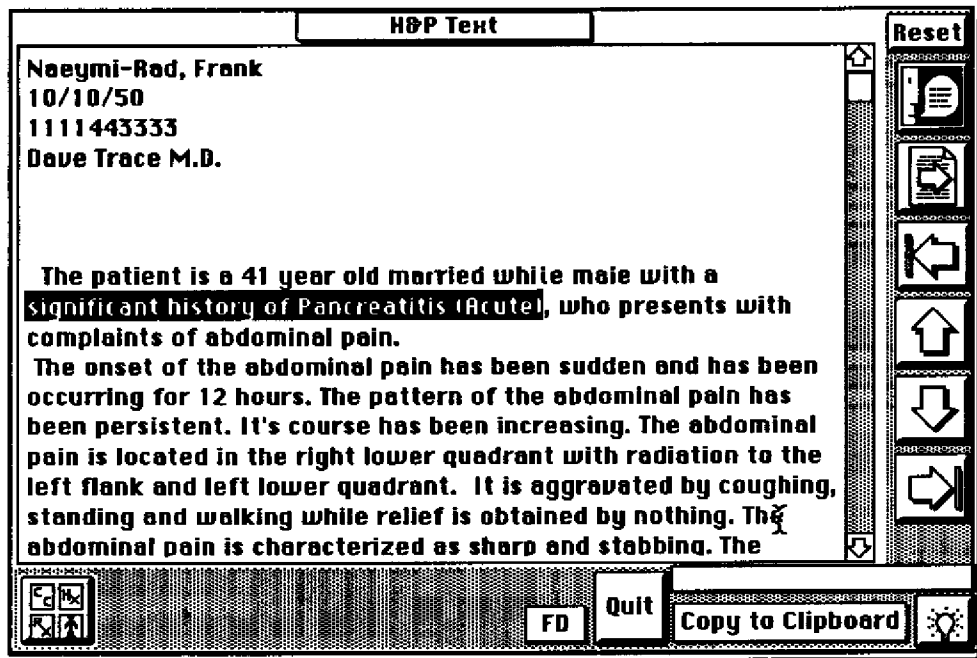


Note: the first paragraph does not have any information about significant past medical or surgical history.

We can go back to where the report generation was launched from by clicking this  icon. by selecting the Gastrointestinal section and identifying the history to the system as significant to the present illness.



When clicking the text  icon, the system displays the current status of the final electronic report with the significant history within the first paragraph.



H&P Text


Naeymi-Rod, Frank
10/10/50
1111443333
Dave Trace M.D.

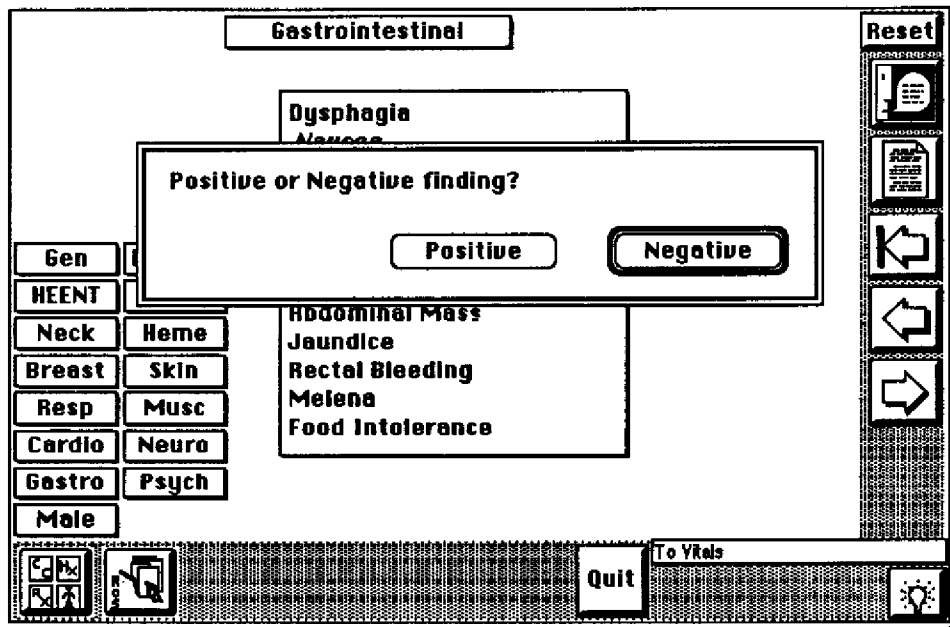
The patient is a 41 year old married white male with a significant history of Pancreatitis (Acute), who presents with complaints of abdominal pain.

The onset of the abdominal pain has been sudden and has been occurring for 12 hours. The pattern of the abdominal pain has been persistent. It's course has been increasing. The abdominal pain is located in the right lower quadrant with radiation to the left flank and left lower quadrant. It is aggravated by coughing, standing and walking while relief is obtained by nothing. The abdominal pain is characterized as sharp and stabbing. The

FD Quit Copy to Clipboard

For the purpose of time, we will return to the first screen and show you other important features needed for a complete electronic medical record.

The next screen is the result of clicking on the REVIEW OF SYSTEM  icon from the main screen. When the selections are made, the system requests the user to respond to the Positive or Negative of the given finding. This insures that significant negatives are entered into the system since the MEDAS expert system uses the negative of the finding as well as the positive.



Gastrointestinal

Dysphagia
Nausea

Positive or Negative finding?

Positive Negative

Gen
HEENT
Neck
Breast
Resp
Cardio
Gastro
Male

Heme
Skin
Musc
Neuro
Psych

Abdominal Mass
Jaundice
Rectal Bleeding
Melena
Food Intolerance

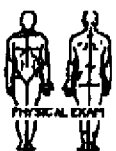
Quit To Vitals

The next screen is the result of clicking on the VITAL SIGN  icon from the main screen.

Vitals

<i>Supine</i>		<i>Standing</i>		
Systolic BP	<input type="text" value="120"/>	Systolic BP	<input type="text"/>	Resp Rate <input type="text" value="22"/>
Diastolic BP	<input type="text" value="80"/>	Diastolic BP	<input type="text"/>	Temp <input type="text" value="102"/>
Heart Rate	<input type="text" value="88"/>	Heart Rate	<input type="text"/>	Weight <input type="text" value="170"/>
				Height <input type="text"/>

Respiration
 Tachypnea (rapid shallow breathing)
 Hyperventilation
 Bradypnea
 Cheyne-Stokes breathing
 Ataxic breathing
 Sighing respiration
 Obstructive breathing












The next screen is the result of clicking on The Physical Exam  icon from the main screen.



Physical Exam


	Normal	Normal Except	Not Examined		Normal	Normal Except	Not Examined		Normal	Normal Except	Not Examined
GENERAL	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	RECTAL	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
SKIN	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	YASC	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>






There are three options for each selection: Normal, Normal Except, and Not Examined. Not Examined will print "not examined" on the report. The Normal will automatically print the significant normal on the report.

Physical Exam

	Normal	Normal Except	Not Examined		Normal	Normal Except	Not Examined		Normal	Normal Except	Not Examined
GENERAL	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	RECTAL	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
SKIN	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	VASC	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>



The next screen demonstrate the output by our selection. The HEET was selected as normal. Please note that the object that generates the significant normal can be modified to print more, or less information on the report.

H&P Text

+ Nausea

- Abdominal Mass

I

PHYSICAL EXAM

VITALS



Supine BP 120/80 Supine HR 88 Temp 102F RR 22 Wt 170


GENERAL Not Examined







SKIN Not Examined


HEENT

AT, NC, PERRLA, EOMI, Fundi w/o exudates or hemorrhages, discs sharp, Ears B/L clear, Oropharynx & sinuses clear.































To select "normal except" for the abdominal exam, click on the Abdomen  icon.

Physical Exam

	Normal	Normal Except	Not Examined		Normal	Normal Except	Not Examined		Normal	Normal Except	Not Examined
GENERAL	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	RECTAL	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
SKIN	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	VASC	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>











Reset









This action will start the abdominal exam program (the following screen). Each Physical Exam has its own unique options. In this exam the options are Inspection, Percussion, and Auscultation.

Abdominal Exam

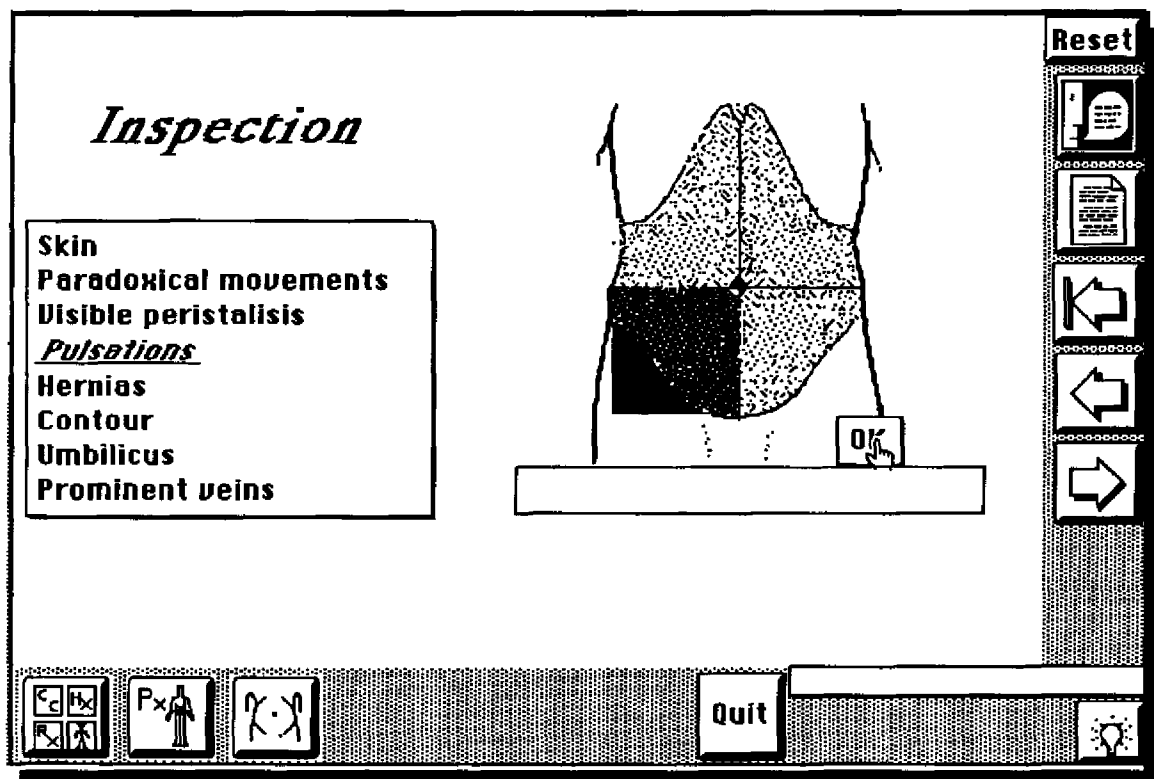


Physical Exam Menu


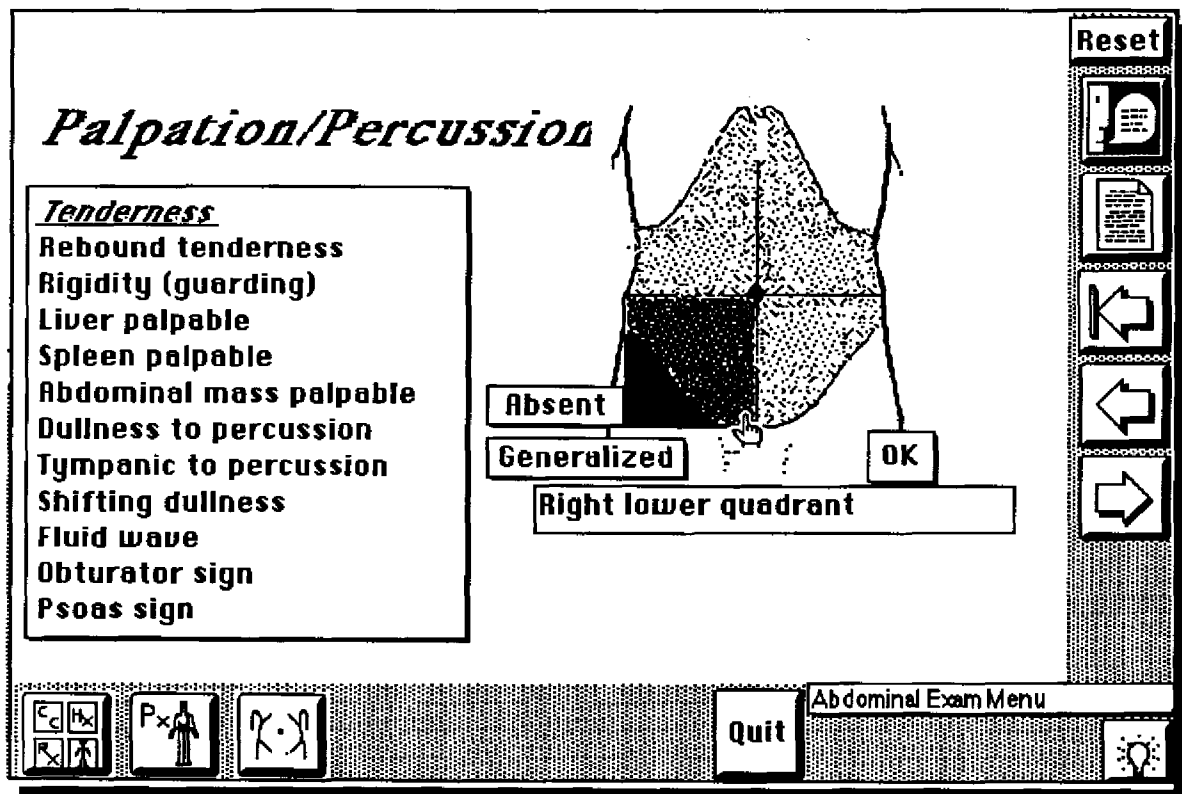
Reset





When selecting "Inspection" the screen controlling the Inspection objects is launched.

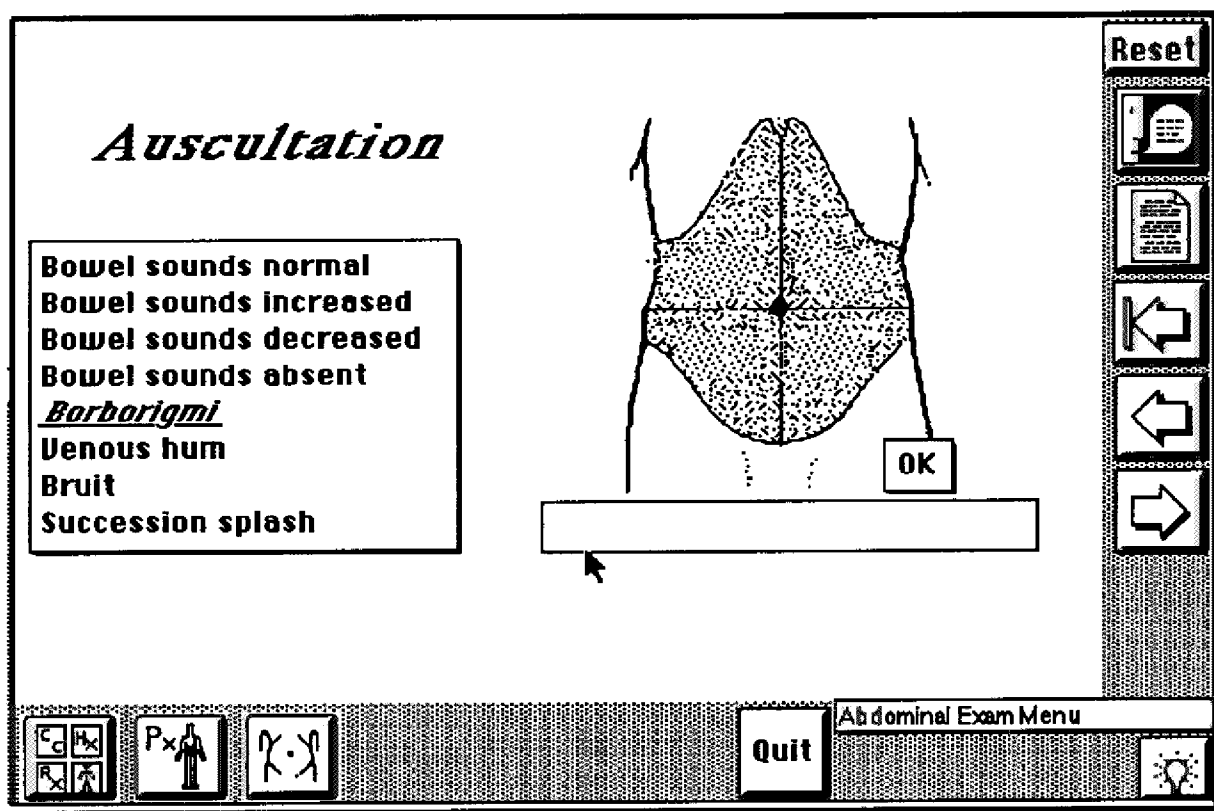


Each of the screens within the physical exam module manage 50 to 300 unique objects.

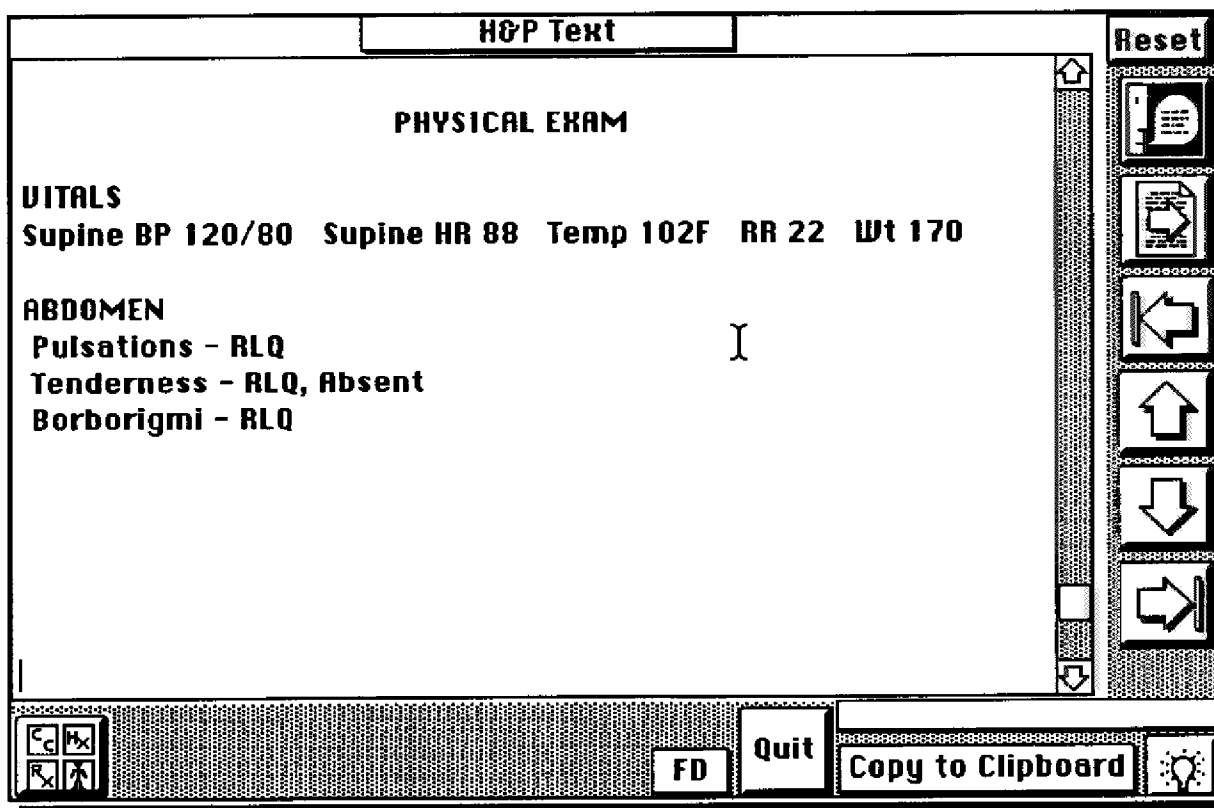
The following is an example of the "Percussion" screen.



The following is an example of the "Auscultation" screen.



This next screen demonstrates the output generated by the physical exam.



When clicking on the FD button on the lower part of the screen, the system generates the term dictionary that can be used to communicate to the expert system.

back	Medas Dictionary
1111443333	
Frank	
Naeymi-Rad	
SEX.1+, male	
RACE.1+, white	
Status.2+, married	
CC.1+, Abdominal pain	
CCAC.37+, fever	
CCAC.56+, nausea	
CCAC.82+, Vomiting	
CC.1.O2+, abdominal pain onset sudden	
CC.1.D2+, abdominal pain duration hours	
CC.1.P2+, abdominal pain pattern persistent	
CC.1.C1+, abdominal pain course increasing	
CC.1.L5+, abdominal pain location right lower quadrant	
CC.1.R5+, abdominal pain radiation left flank	
CC.1.R12+, abdominal pain radiation left lower quadrant	
CC.1.A5+, abdominal pain aggravated by coughing	
CC.1.A7+, abdominal pain aggravated by standing	
CC.1.A8+, abdominal pain aggravated by walking	
CC.1.RE1+, abdominal pain relieved by nothing	
CC.1.CH2+, abdominal pain characterized as sharp	
CC.1.CH3+, abdominal pain characterized as stabbing	
CC.1.AS13+, abdominal pain associated with fever	
CC.1.AS19+, abdominal pain associated with nausea	
MEDS.97+, BENZATHINE PENICILLIN G,97	
PMHCY.38+, Cardiovascular Pulmonary Hypertension	

As you can see, the system generates many terms for this very simple exam. The current system generates over 65,000 terms while the current MEDAS data dictionary has only 1,750 of these terms.

In conclusion we have demonstrated the need of an independent and complete front-end to a medical expert system.