

FROM OPTICAL SCAN SHEETS OR DATABASES TO OUTPUT: HOW SAS®¹ TAKES US THERE

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Introduction

SAS® software provides a kaleidoscope of procedures, graphical outputs, connectivity avenues, and data manipulation options. Part of the usefulness of SAS® is its ability to read and analyze data from a variety of software packages and formats. This is particularly important for investigations designed following the data collection phase. A *priori* investigations also benefit from SAS's® flexibility, for researchers are always searching for methods to facilitate the data input phase of their investigations. This paper describes the utility of SAS® in such situations through actual applications.

Application #1: Data from Two Different Sources

As is often the case in academia, there is a lack of consistency in hardware and software across departments. Fiscal and staff support issues are largely responsible for the variability. Fortunately, SAS® provides a method to overcome the integration and analysis of non-identically formatted data. This is accomplished through SAS®'s wide variety of engines and flexibility of INPUT statements.

This application utilized the SAS® System for Windows version 6.08. Data from both dBase®² IV and ASCII data formats were utilized. Although the original data were from optical scan forms, two different scanners and sets of forms were employed (Figures 1 and 2). The first set resulted in data in a dBase IV format, while the second set resulted in ASCII data in a fixed column format. The reason for the differences is that two separate departments were responsible for each set of data. Each department collected data necessary for its own needs. One department graded student performance on the practical exam, while the other surveyed the feedback information observing faculty members provided each student.

A group of investigators decided to examine the effect of faculty feedback during a second year medical student practical examination commonly called an OSCE (Observed Structured Clinical Examination). The examination consisted of four three-station triplets, resulting in twelve sequential stations. Two triplets centered on one presenting complaint (chest pain and back pain, respectively) and consisted of a history taking, a physical examination, and a presentation station. Figure 3 provides a schematic of the data collected during this examination.

In the history taking station, the student asked the standardized patient (SP) history questions. After the encounter, the SP recorded what items the student covered via a scannable checklist (See Figure 2 for an example). Next, the student entered a physical examination station where he/she was to perform a focussed physical exam on an SP based on the presenting complaint from the previous station. After the encounter, again, the SP completed a scannable checklist regarding the student's performance. In the last station of the triplet, the presentation station, the student presented his/her findings from the previous two SP encounters (history and physical exam) to a faculty member. After the student made his/her case presentation, the faculty member was to give the student feedback. Each faculty member was provided with a checklist of items to discuss with the student during the feedback session. Observers were present for these encounters and recorded via an optical scan form the feedback items covered by the faculty member.

The other two triplets of stations paralleled the first, except for the third station. Instead of being a presentation station, it was an additional physical examination station. Therefore, no presentation feedback was available for these two triplets. The presenting complaints for these two triplets were headache and abdominal pain.

Thus, there were several sources of data regarding student performance on this practical examination. First, we had the data provided by the SPs and the faculty members for student performance and scanned via an NCS scanner on form NCS #70921 (an example is shown as Figure 1) by the department conducting the OSCE that was in a dBase IV format. Data from each of the twelve OSCE stations was in individual files; therefore, twelve dBase files had to be read by SAS®.

In addition, several items were included on checklists across the triplets. For

example, in the history stations, data were collected regarding students' inquiries about patient identifiers, chief complaint, temporal description, location description, etc. In two of the physical exam stations, data were collected about students' examination of femoral pulmonary artery and edema. In the other two physical exam stations, data were collected regarding students' examination of knee and ankle.

Besides the SP data just described, we had the data gathered from the observers of the student-faculty encounter on form SCANTRON #24646-ERI (Figure 2). These were gathered and scanned via a SCANTRON scanner by the author's department and were in an ASCII fixed column format. The link between the two sets of data was student social security number.

The ASCII data were pre-sorted by student social security number and read by SAS® via an INFILE statement. (The reason for this is that data may not be sorted within a data step VIEW). A data step VIEW was used to process the external ASCII file. This method was utilized to minimize the amount of hard disk space used in the combining of the two sets of data.

Since it was hypothesized that the order in which the student progressed through the stations and the type of feedback (i.e., positive or negative) received would influence student performance in subsequent stations, it was necessary to include variables to indicate order. This was accomplished by creating variables within each data step that read in the .dbf files.

ASCII data were MERGED with the dBase IV data by student social security number. The resultant SAS® dataset maintained the order of student progression through

the stations and included all of the pertinent data from both sources. This allowed the post-hoc research questions to be investigated through SAS® statistical procedures.

The next examples demonstrate the utility of using SAS® in conjunction with NCS Optical Scanner 5 software and scanning capabilities. It was through the NCS package that the co-author's office was able to offer several mediums of data collection and entry that could later be read by SAS®.

Application #2: Pre-Designed (Standard) Scannable Forms

NCS provides several standard scannable forms that may be selected by users. The School of Medicine at the University of Texas Medical Branch has been using three of these pre-packaged forms for more than ten years. The most commonly used form is NCS #30423 that allows a maximum of 240 items with a maximum of 5 responses each (See Figure 4). There are also slots for demographic information such as, name, identification number, gender, grade, year and month of birth, and an additional special code. The second commonly used form is NCS #6703. It includes a maximum of 120 response fields with up to 10 options each (See Figure 5). Another common form, NCS #87422, allows only 100 items, but will permit up to 20 responses per item (See Figure 6). The latter is only capable of including id number and special code, rather than the full gamut of demographic data available for input in the aforementioned forms. While this form does allow a space for an individual's name to be written, this information is not scanned. For medical school purposes, the identification number on all three forms is filled in by the student with their social security number. The special code is a randomly generated number that is assigned to each student at the beginning of the semester and

which the student is expected to remember. To maintain confidentiality, grades are posted using this number instead of social security number.

Students transfer their answers from the exam to the corresponding number on the scannable form. The forms are then scanned. The co-author has written three programs for the scanner, one for each of the above described NCS forms. The appropriate program to scan and produce an ASCII file of the exam data is selected by the individual doing the scanning. Typically there are 200 to 220 students and, therefore, data sheets to scan for each exam.

Although as many as twenty responses may be available for an item, it is strongly encouraged by the office that only one answer be allowed. This is because the biostatistician, who is a top notch SAS® programmer, has written a program that compares the answers to the answer key to determine if a response is right or wrong. The program also computes descriptive statistics and produces a detailed item analysis based on one correct response per question. The program is set up to read macros that are controlled by the number of students and the number of exam questions. This enables someone with basic SAS® programming skills to run the program. He/she simply fills in the filename of the ASCII exam data, the number of students, and the number of questions.

In addition to producing a report with the above information, the co-author has also added an option to output the students' names, social security numbers, special codes (if available), and grades to an ASCII file that the instructor may then integrate into his/her own word processor or spread sheet. Grades are then posted by the instructor and then students are permitted several days to challenge the answers. Typically, the instructor returns with items to omit from scoring as well as changes in the answer key. In order to

anticipate such changes in the scoring protocol, the co-author has included an array within the SAS® scoring program (that is commented out until it may be needed) that allows the individual doing the scanning to modify the program to fit the instructor's scoring changes. The reports and ASCII files are then recreated based upon the revised program and output.

Application #3: Manual Data Entry

Researchers frequently create a survey, administer it, and then request that the office enter the data and conduct the data analyses. When data are received in this format, one method to prepare the data for analysis by SAS® software is to have a data entry clerk enter the data from the hard copies of the completed surveys into an ASCII file. This is a method innately fraught with difficulty, since there are many opportunities for data entry error. One strategy for compensating for this is to have two data entry clerks enter all of the data and then utilize SAS®'s PROC COMPARE. This procedure identifies the non-identical responses for each item. Using this information, the original data are used to arbitrate any discrepancies.

Application #4: Data Entry Screens into Database

The Office of Biostatistics has offered its services campus-wide. A brochure was circulated that described the available services, including survey design, sampling techniques, data entry or scan programs for surveys, and analyses. As a result, more and more campus clients are seeking these services. Clients are encouraged to develop

surveys that are as self-coding as possible. After a survey has been reviewed by both a biostatistician and the co-author, revisions, if any, and a suitable method of data collection are recommended. If it is a lengthy survey, a data entry program written in Clipper³ (a dBase compiler) is often suggested. This is because Clipper allows computer screens to be created that mimic the actual format of the original survey instrument. In some instances, the client may elect to have his/her staff enter the data. In others, he/she may request that the Office of Biostatistics enter the data. In either case, a dBase file is created that is then read by SAS® via SAS/ACCESS and PROC DBF.

Application #5: Custom Designed Scannable Forms

The process associated with a custom designed form parallels that for a pre-designed form described for Application #2, except that a form is especially designed based on a client's needs. When a short survey is involved, a custom scannable form that is easily and quickly scanned is created (See Figure 7 for an example). As with Application #2, an ASCII file results from the process that is then read in by SAS® via an INPUT statement. Longer surveys may also be adapted to scannable forms by dividing the survey across several forms. This is accomplished by having an identifier on each page of the scannable form that is then used to MERGE the files together by SAS®. In addition, the scanner can produce identification numbers that may be read from the resultant ASCII files and employed in a MERGE statement.

Conclusions

It is clear that a post-hoc analysis does not usually allow for changes in data collection techniques. As a result, SAS® once again provides the mechanism by which a variety of data formats may be integrated and analyzed. In an environment where *a priori* investigations are not necessarily the norm, SAS® comes the rescue.

Obviously when data are collected with a purpose, applications 2, 4 and 5 are the most practical. Application 4 has more work up front with the creation of the data entry screens and database, but it can be brought directly into SAS® via **PROC DBF** without the use of an **INPUT** statement. Initially, Applications 2 and 5 have slightly less work but both require a SAS® **INPUT** statement.

Generally, no sophisticated statistics are requested by campus clients, merely descriptive information. Labels and formats are created, **PROC FREQ** and **PROC MEANS** or **PROC UNIVARIATE** are run, and the work is complete. The data are always saved as SAS® system files to have for use at a later time. Frequently, a researcher will have additional questionnaires come in after the cutoff date and the original system file has to be updated. This is no problem with SAS®. In other cases, they begin a new year or a second wave of data collection which they may want **MERGED** or **SET** with the original data so that comparisons can be made. Once again, SAS® and its power of data manipulation come to the rescue.

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1. SAS® & SAS/ACCESS® are registered trademarks of SAS Institute, Inc. in the USA.
 2. dBase®, dBase IV® are registered trademarks of Ashton-Tate, Inc.
 3. Clipper® is a registered trademark of Nantucket, Inc.

ID NUMBER										SPECIAL CODES									
										A	B	C	D	E	F	G	H	I	J
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
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GCRCAP
PRECLINICAL OSCE

CHEST PAIN HX 93A
Case 2
Station 4

GENERAL PURPOSE DATA SHEET II
form no. 70921



Facilitation of Patient Encounter:

1. Introduced self-----
2. Began interview with at least two open-ended questions-----
3. Maintained comfortable eye contact-----
4. Seemed interested (facial expressions, posture)-----
5. Speech easily heard and understood-----
6. Used language I could understand-----
7. Avoided complex, run-on, or leading questions-----
8. Used reinforcing behaviors-----
9. Note taking did not disrupt interview-----
10. Did not interrupt me-----
11. Asked about my concerns about my symptoms-----
12. Summarized history of my present illness-----

B = NOT DONE
A = DONE

Historical Data Collection:

13. Asked me when/how the pain started-----
14. Asked me where the pain is located-----
15. Asked me what the pain is like-----
16. Asked me how often the pain occurs-----
17. Asked me how long the pain lasts-----
18. Asked me how severe/strong the pain is-----
19. Asked me what brings the pain on-----
20. Asked me what makes the pain worse-----
21. Asked me what makes the pain better-----
22. Asked me if the pain moves/radiates-----
23. Asked me if I have had the pain before-----
24. Asked me if I have any other symptoms with the pain-----
25. Asked me if I have a family history of this problem-----
26. Asked me about smoking, HTN, and cholesterol-----

27. Extent student established rapport:
A=Very well B=Moderately well C=Not very well D=Not at all-----

Figure 1

SSN:

GENERAL SURVEY

Preventive Cardiology Checklist

CHEST PAIN PRS 93A

Case 2, Station 6

Indicate: 5 = FEEDBACK W/INSTRUCTION
 4 = FEEDBACK W/ADDITIONAL INFO
 3 = FEEDBACK W/O ADDITIONAL INFO
 2 = NO FEEDBACK

Content:

1. Patient identifiers (age, sex, ethnicity).....
2. Chief complaint.....
3. Temporal description (onset, duration, frequency).....
4. Location description (location, radiation).....
5. Character description (quality, severity).....
6. Aggravating factors.....
7. Relieving factors.....
8. Associated symptoms.....
9. Family history of chest pain or heart disease.....
10. Describes general appearance of patient.....
11. Describes neck veins.....
12. Describes lung exam (crackles, wheezes).....
13. Describes cardiac exam (rhythm, pmi, s1, s2, s3, s4, murmur).....
14. Describes ASCVD risk factors.....

Style:

16. Proper medical terminology.....
 17. Data presented without commentary.....
 18. Data organized by section.....
 19. Speech fluent (volume, clarity, pace).....
 20. Overall skill of presentation.....
- ASCVD Risk factors STUDENT COVERED: 5 = Yes 4 = No**
22. Smoking.....
 23. Hypertension/high blood pressure.....
 24. Cholesterol.....
 25. Family history of heart disease.....
 26. Tell me where you learned about cardiac risk factors.....

27. What does it mean to have CVD risk factors?
 How are they important in this case?

Date: _____

Patient: _____ Room: _____ Time: _____ AM PM

Student: _____ M / F (Circle 1)

Faculty: _____ M.D.?

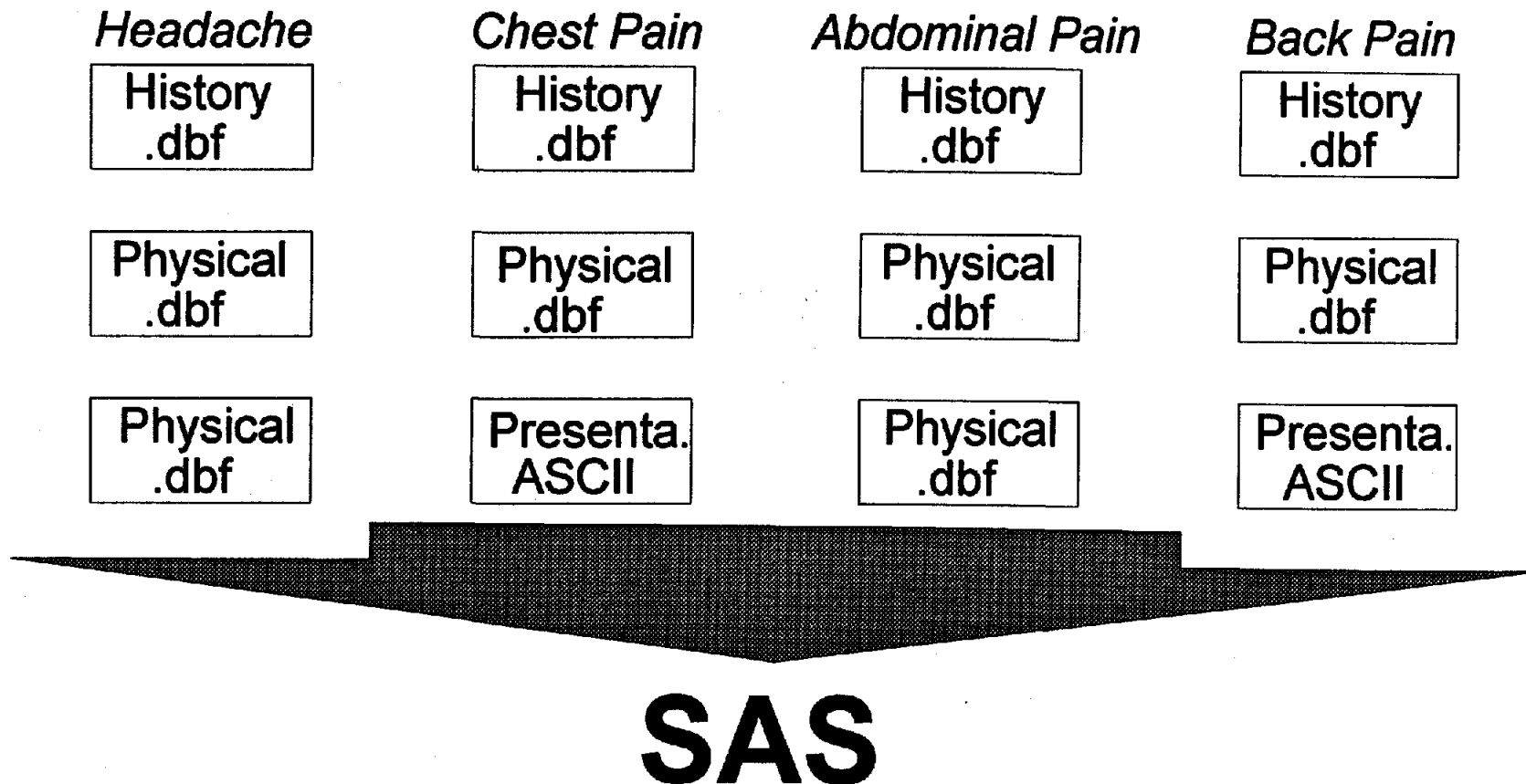
C:\SCSUG\FIGURE2.WP6

Figure 2
 SIDE 1

Figure 3

Schematic

OSCE Research Example



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From Optical Scan Sheets to Output: How SAS Takes Us There
Stroup-Benham and Ray

form no. 30423

EXAMPLE

WRONG

1 ☐ ☒ ☐ ☐ ☐

WRONG

2 ☐ ☒ ☐ ☐ ☐

WRONG

3 ☐ ☐ ☒ ☐ ☐

RIGHT

4 ☐ ☐ ☐ ☒ ☐

IMPORTANT DIRECTIONS FOR MARKING ANSWERS

Use #2 pencil only.

Make heavy black marks that fill the circle completely.

Erase clearly any answer you wish to change.

Make no stray marks on this answer sheet.

← REFER TO THESE EXAMPLES BEFORE STARTING PRACTICE EXERCISES →

PRACTICE

A B C D E

1 ☐ ☐ ☐ ☐ ☐

A B C D E

2 ☐ ☐ ☐ ☐ ☐

A B C D E

3 ☐ ☐ ☐ ☐ ☐

A B C D E

4 ☐ ☐ ☐ ☐ ☐1 A B C D E
☐ ☐ ☐ ☐ ☐11 A B C D E
☐ ☐ ☐ ☐ ☐21 A B C D E
☐ ☐ ☐ ☐ ☐31 A B C D E
☐ ☐ ☐ ☐ ☐41 A B C D E
☐ ☐ ☐ ☐ ☐51 A B C D E
☐ ☐ ☐ ☐ ☐2 A B C D E
☐ ☐ ☐ ☐ ☐12 A B C D E
☐ ☐ ☐ ☐ ☐22 A B C D E
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[illegible]

SEX	GRADE OR EDUC
(M)	(0)
(F)	(1)
	(2)
	(3)
	(4)
	(5)
	(6)
	(7)
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	(9)
	(10)
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	(16)

[illegible]

I.D. NUMBER										SPECIAL CODE					
										A	B	C	D	E	F
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1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
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8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9

Place Label Here

NAME (Print Last, First, M.I.)

GENERAL PURPOSE - NCS® - ANSWER SHEET
SEE IMPORTANT MARKING INSTRUCTIONS ON SIDE 2

1	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
2	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
3	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
4	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
5	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
6	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
7	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
8	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
10	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
11	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
12	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
13	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
14	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
15	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
16	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
17	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
18	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
19	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
20	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T

21	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
22	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
23	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
24	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
25	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
26	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
27	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
28	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
29	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
30	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
31	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
32	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
33	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
34	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
35	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
36	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
37	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
38	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
39	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
40	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
41	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
42	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
43	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
44	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
45	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
46	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
47	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
48	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
49	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
50	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T

■■■

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PATIENTS' OPINIONS REGARDING DISCLOSURE OF RADIOLOGY FINDINGS

Please fill in your choices in the oval corresponding to each question.
Erase completely any answer you wish to change.
Make heavy dark marks.

Proper Mark



A radiologist is a physician (M.D.) who interprets your x-rays or other imaging tests (ultrasound, CAT scan, etc.). He or she ordinarily reports the results to your doctor.

- | | |
|---|---|
| 1. If the results are normal,
do you want the radiologist to tell you? | <div style="display: flex; justify-content: space-around;"><div>Yes
☐</div><div>Yes,
but only if I ask
☐</div><div>No
☐</div></div> |
| 2. If the results are abnormal (cancer, for example),
do you want the radiologist to tell you? | <div style="display: flex; justify-content: space-around;"><div>Yes
☐</div><div>Yes,
but only if I ask
☐</div><div>No
☐</div></div> |
| 3. Would you prefer to hear the results from your family
doctor, internist or other primary care provider? | <div style="display: flex; justify-content: space-around;"><div>Yes
☐</div><div>No
☐</div></div> |
| 4. If you request it, are you entitled to an explanation
of the test results by the radiologist? | <div style="display: flex; justify-content: space-around;"><div>Yes
☐</div><div>No
☐</div></div> |