MOS CORE MEASURES OF HEALTH-RELATED QUALITY OF LIFE

The MOS longitudinal panel was administered a much more extensive battery of measures than that fielded in the cross-sectional screening phase of the study. The MOS measurement book describes 149 functioning and well-being items that were administered to the panel patients (Stewart, Sherbourne, Hays et al., 1992). We discuss the core set of 116 of these items here. These items are "core" in the sense that the MOS investigators determined them to be the set that defined a comprehensive battery of functioning and well-being indicators in the study. Of the 116, 113 were described in detail in the MOS book (Stewart et al., 1992) and 3 others were added here to round-out the picture. SF-36™ is a subset of these items.

The MOS measures were based on a comprehensive conceptual model that includes two overarching dimensions of health--physical and mental (Stewart, Sherbourne, Hays et al, 1992). Hays and Stewart (1990) provide empirical support for these two health dimensions. Conceptually, the MOS measures were constructed to represent the following: *Physical Health* (e.g., physical functioning, satisfaction with physical ability, mobility, pain effects, pain severity, role limitations due to physical health), *Mental Health* (e.g., psychological distress——anxiety and depression, psychological well-being——positive affect and feelings of belonging, cognitive functioning, role limitations due to emotional problems), and *General Health* (e.g., energy/fatigue, sleep problems, psychophysiologic symptoms, social functioning, role functioning——unable to work, role functioning——unable to do housework, current health perceptions, and health distress). A detailed description of these measures and their development is provided elsewhere (Hays & Stewart, 1992a; Sherbourne, 1992a,b; Sherbourne, Allen, Kamberg et al., 1992; Sherbourne, Stewart, & Wells, 1992; Stewart & Kamberg, 1992; Stewart, Hays & Ware, 1992a; Stewart, Sherbourne, Hays et al., 1992).

Table 1 defines each of the HRQOL measures scored from the 116-item core. The 116 items used to score each of the measures are shown in Appendix A. Note that there are several versions of some measures (e.g., Psychological Distress I and Psychological Distress II, Mental Health Index (MHI) I, II, and III). The version I measures are based on the full battery included in the MOS baseline patient assessment questionnaires. To reduce respondent burden, scales from a subset of items (i.e., the version II scales) were also developed without sacrificing reliability. For mental health, a third version of the overall index (MHI-III) was also developed and is identical to the SF-20 and the SF-36™

versions (Hays, Sherbourne, & Mazel, 1993; Ware & Sherbourne, 1992; Ware, Sherbourne, & Davies, 1992).

Below we describe the scoring of these measures, provide descriptive information about them, and summarize their data quality.

SCORING THE MOS CORE MEASURES OF HEALTH-RELATED QUALITY OF LIFE

The MOS HRQOL scales are scored in five steps: (1) data-cleaning (e.g., changing out-of-range values to missing), (2) item recalibration and skip pattern recoding, (3) reverse scoring of items, (4) transforming item scores linearly to a common metric with a possible range of 0-100; and (5) averaging across items in the same scale. We also provide recommendations concerning estimation of missing data. Note that item names correspond to items in Appendix A, beginning with CORE1 (the name of the first item in Appendix A) and increasing sequentially.

Appendix B provides the SAS[1] scoring statements that can be used to create the HRQOL scales.

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[1] SAS is a registered trademark of SAS, Inc. in the USA and other countries.

Table 1

DEFINITIONS OF 116-ITEM MOS CORE FUNCTIONING AND WELL-BEING CONCEPTS

Measure	No. of Items	Definition
Physical Functioning	10	Extent to which health limits physical activities such as self-care, walking, climbing hills and stairs, bending, lifting, and moderate and vigorous activities (same version used for the MOS SF-36™ short form)
Satisfaction with Physical Ability	1	Satisfaction with physical ability to do what is wanted
Mobility	2	Amount of time in bed or chair-all or most of the day-and amount of time needs assistance getting around community
Effects of Pain	6	Effects of pain on daily activities, including ability to walk, sleep, work; on recreation and on mood and life enjoyment during past 4 weeks
Pain Severity	5	Pain intensity (average and at its worst), frequency, duration during past 4 weeks
SF-36™ Pain	2	Amount of pain interference in daily activities (including work and housework)
Role Limitations Due to Physical Health	7	Limitations in work or other regular activities during the past 4 weeks, such as took frequent rests, limited in kind of work, had difficulty, or accomplished less than wanted
SF-36™ Role Limitations Due to Physical Health	4	SF-36™ short form version including limitations in activities during the past 4 weeks, such as less time spent on activities, limited in kind of work, had difficulty, or accomplished less than wanted
Cognitive Functioning	6	Amount of time in past month became confused, reacted slowly to things, had difficulty reasoning, was forgetful, had trouble keeping attention, had difficulty concentrating
Mental Health Index I	32	Includes depression/behavioral-emotional control, anxiety, feelings of belonging, positive affect
Psychological Distress I	22	Amount of time during past month very nervous, bothered by nervousness, tense, difficulty calming down, anxious, rattled or upset, restless, fidgety, low spirits, downhearted, depressed, moody, depression interfered with life, down in dumps, nothing to look forward to, not in firm control of behavior, felt like crying, felt others better off if dead, not emotionally stable, thought about taking own life

Table 1——Continued

Measure	No. of Items	Definition
Depression/ Behavioral-Emotional Control I	13	Amount of time in past month felt in low spirits, downhearted, depressed, moody, down in the dumps, nothing to look forward to, not in firm control of behavior, felt like crying, felt others better off if dead, not emotionally stable, thought about taking own life
Anxiety I	6	Amount of time in past month very nervous, bothered by nervousness, tense, high strung, difficulty calming down, rattled or upset, restless, fidgety
Psychological Well-Being I	10	Amount of time in past month been happy, enjoyed things, felt calm and peaceful, satisfied, felt living was an adventure, felt cheerful, daily life interesting, love relationships full, felt loved, felt close to people
Positive Affect I	7	Amount of time in past month been happy, enjoyed things, felt calm and peaceful, happy, satisfied, pleased, felt living was an adventure, cheerful, lighthearted, daily life interesting
Feelings of Belonging	3	Amount of time in past month felt love relationships full, felt loved, felt close to people
Mental Health Index II	17	Includes depression/behavioral-emotional control, anxiety, feeling of belonging, positive affect
Psychological Distress II	12	Amount of time in past month very nervous, tense, anxious or worried, restless, fidgety, low spirits, downhearted
Depression/ Behavioral-Emotional Control II	8	Amount of time in past month felt in low spirits, downhearted, depressed, moody, down in dumps, nothing to look forward to, not in firm control of behavior, not emotionally stable
Anxiety II	3	Amount of time during past month been very nervous, tense, restless
Psychological Well-Being II	5	Amount of time during past month been happy, calm and peaceful, cheerful, daily life interesting, felt loved
Positive Affect II	4	Amount of time in past month been happy, felt calm and peaceful, felt cheerful, daily life interesting
Mental Health Index III	5	Amount of time during past month very nervous, downhearted, down in dumps; happy, calm, and peaceful (same version used for the RAND SF-36™)
Role Limitations Due to Emotional Problems	3	Limitations in work or other regular daily activities due to emotional problems during past 4 weeks, including cutting down amount of time spent, accomplished less than wanted, didn't do work as carefully as usual (same version used for SF-36™)

Table 1——Continued

Measure	No. of Items	Definition
Energy/Fatigue	5	Amount of time in past month felt full of pep, energetic, worn out, tired, or had enough energy to do things wanted to do
SF-36™ Vitality	4	Amount of time in past month felt full of pep, worn out, tired, or had a lot of energy
Sleep Problems I	9	Sleep disturbance, adequacy, somnolence, and awaken short of breath during past 4 weeks
Sleep Problems II	6	Sleep disturbance, adequacy, somnolence, and awaken short of breath during past 4 weeks
Physical/ Psychophysiologic Symptoms	8	Frequency of occurrences of 8 general (non-disease-specific) symptoms, including stiffness, pain, swelling, or soreness of muscles or joints; coughing that produced sputum; backaches; nausea, acid indigestion; heavy feelings in arms and legs; headaches; lump in throat, all during the past 4 weeks
Social Activity Limitations Due to Health	4	Limitations in normal social activities during past 4 weeks due to physical health or emotional problems, comparison of these limitations to those of others their age, and changes in social activities over last 6 months because of changes in physical or emotional condition
SF-36™ Social Functioning	2	SF-36™ short form version, includes the extent of limitations by physical health or emotional problems in normal social activities
Role Functioning:		
Able to Work	1	Unable to work due to health (dichotomous measure)
Able to Do Housework	1	Unable to do housework due to health (dichotomous measure)
General Health Perceptions:		
Current Health	7	Rating of overall current health (e.g., I have been feeling bad lately)
SF-36™ General Health	5	Ratings of current health, future health, and resistance to illness
SF-20 Current Health	5	Ratings of overall current health
Health Distress	6	Amount of time in past month feeling distressed about health (e.g., discouraged by health, worry about health, afraid because of health)

Note: This table is adapted from Table 20-3 of Stewart, Sherbourne, Hays et al., 1992.

Step One: Data Cleaning

Keypunch and other errors can result in an item having an out-of-range value (i.e., values that are lower or higher than an item's minimum and maximum value). We recommend recoding all out-of-range values to missing data. For example, item CORE8a "Did you feel worn
out" has response choices that range from a minimum of 1 to a maximum of 6. Any responses outside of this range should be assigned a missing value. The SAS statements in Appendix B (under the heading "Step 1: Data Cleaning") use SAS arrays (variable lists) for items with the same number of response choices to recode out-of-range values in a single step. For example, array fr1to6 contains the CORE8a item (having 6 response choices). The following SAS "do" statement recodes out-of-range values for this item (and the other 59 items in the array) to missing:

```
do i = 1 to 60;
        if fr1to6(i) < 1 | fr1to6(i) > 6 then fr1to6(i) = .;
end;
```

Step Two: Item Recalibration and Skip Pattern Recoding

Before scoring the MOS HRQOL scales, there is one item (CORE1) that is recalibrated while being reversed in direction (see Table 2). In the MOS, it was decided that the distances between response choices were unequal and that they should be adjusted in scoring the item. (Note that this recalibration step is skipped for this item in SF-36™ scoring procedure.)

Table 2

ITEM RECALIBRATION AND SKIP PATTERN RECODING

ITEM NAME	If original response category is:	Recode to value of:
CORE1	1 ---------->	5
	2 ---------->	4.36
	3 ---------->	3.43
	4 ---------->	1.99
	5 ---------->	1
CORE10 >>>and<<< CORE11, CORE 12, CORE14, CORE15	2 MISSING ---------->	0
CORE10 >>>and<<< CORE13a-CORE13f	2 MISSING ---------->	1

Note: Recoded item names are the same as those listed under item name above with an "R" (recoded) added as the first letter.

In addition, a special scoring method is used for the pain measures (including items CORE11, CORE12, CORE13a-CORE13f, CORE14, and CORE15) to accommodate the skip pattern in the MOS questionnaire. To reduce respondent burden, we asked respondents who reported no bodily pain in the past 4 weeks (on item CORE10) to skip the remaining pain items.

Rather than have missing data on the pain scales for people who were asked to skip the battery of pain items because they were pain-free, we assigned them a score on each item they skipped that represents "no pain" for each of these items. Specifically, for items CORE11, CORE12, CORE14, and CORE15, people who responded "2" to CORE10 were assigned a 0, and for items CORE13a-CORE13f, people who responded "2" to CORE10 were assigned a 1. (Then all items are reversed so that high scores reflect favorable health——in this case, the absence of pain; instructions will follow in Step Three.) SAS_statements used to perform both recalibration and pain item recoding can be found in Appendix B under the heading "Step 2: Item Recalibration and Skip Pattern Recoding."

Step Three: Item Reverse Scoring

All scales are scored so that a high score defines a more favorable health state. Note that this differs from the convention used in the MOS book (Stewart, Sherbourne, Hays, et al., 1992) in which all measures were scored so that a high score corresponded to the label for the measure (e.g., on a pain severity scale, a high score represented more pain). This manual takes a different approach to facilitate consistent comparisons and profiles across groups (i.e., for each scale, the group with the larger score is doing better).

The third step in scoring each scale involves recoding item responses for those items that are not asked in a direction consistent with a favorable health state. For example, the item CORE8g asks, "Did you have enough energy to do the things you wanted to do?" If a respondent answers, "none of the time," the precoded response of "6" must be reversed so higher scores will indicate a favorable health state (i.e., more frequent occurrences of having enough energy). Item scoring rules for items that need to be recoded are given in Table 3. SAS_

Table 3

ITEM REVERSE SCORING

ITEM NAME	Change original response category (a)	Recode to value of:
CORE3, CORE9a-CORE9h, CORE61b, CORE 61e, CORE61f, CORE3a-CORE3f	1 ==========>>	5
	2 ==========>>	4
	3 ==========>>	3
	4 ==========>>	2
	5 ==========>>	1
CORE2, CORE5, CORE8c, CORE 8e, CORE 8g, CORE20, CORE21, CORE24-CORE26, CORE31, CORE34, CORE 35, CORE 41, CORE43, CORE51,CORE54, CORE62b, CORE62i	1 ==========>>	6
	2 ==========>>	5
	3 ==========>>	4
	4 ==========>>	3
	5 ==========>>	2
	6 ==========>>	1
CORE11 and CORE12	0 ==========>>	5
	1 ==========>>	4
	2 ==========>>	3
	3 ==========>>	2
	4 ==========>>	1
	5 ==========>>	0

CORE 14, CORE15	0	==========>>	20
	1	==========>>	19
	2	==========>>	18
	3	==========>>	17
	4	==========>>	16
	5	==========>>	15
	6	==========>>	14
	7	==========>>	13
	8	==========>>	12
	9	==========>>	11
	10	==========>>	10
	11	==========>>	9
	12	==========>>	8
	13	==========>>	7
	14	==========>>	6
	15	==========>>	5
	16	==========>>	4
	17	==========>>	3
	18	==========>>	2
	19	==========>>	1
	20	==========>>	0

[a]Precoded response choices as printed in the questionnaire in Appendix A. Note: Recoded item names are the same as those listed under item name above with an "R" (recoded) added as the first letter.

statements in Appendix B (under the heading "Step 3: Concept Consistency Recoding") illustrate an easy method for reversing items that are not in the direction of a high score defining favorable health. For example, item CORE8g is included in an array with other items that have six response choices and need to be reversed (array rfr1to6 includes the reversed items and array ofr1to6 includes the items as originally precoded in the questionnaire). The following SAS® "do" statements reverse items that have 6 response choices:

```
do i = 1 to 19;
        rfr1to6(i) = 7 - ofr1to6(i);
end;
```

Step Four: Transforming Items to a 0–100 Possible Range

The fourth step involves transforming each item linearly so that the lowest and highest possible scores are set at 0 and 100, respectively. In this way, it is possible to combine items with different numbers of response categories into a single score. Scale scores represent the percentage of total possible score achieved. Table 4 provides transformation formulas for each of the 116 CORE items.[2] Note that items included in the transformation formula are the recoded items, according to Tables 2 and 3, which have a high score equal to good health. Appendix B (under the heading "Step 4——Transforming Items for Range Conformity") shows how arrays are used to process all items with the same number of response codes in one step.

Step Five: Deriving Scales

The final step involves simply averaging the scores for items in the same scale. This simple scoring method is possible because all items in a given scale have roughly equivalent relationships to the underlying HRQOL concept being measured and each item is used to

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[2] A general formula to transform linearly to a 0-100 range is:
New score = 100 x (old score - lowest score possible) / (score range)
[score range = highest possible score - lowest possible score].

Table 4

TRANSFORMING ITEMS TO A 0-100 RANGE

Item Response Range ITEM NUMBERS	Recoding Formula	Original Response	Recoded Value
From 1 to 2:			
CORE16a-CORE16g, CORE17a-CORE17c, CORE18, CORE19	NEW = (CORE - 1) x 100	1 ------>	0
		2 ------>	100
From 1 to 3:			
CORE4a-CORE4j	NEW = (CORE - 1) x 50	1 ------>	0
		2 ------>	50
		3 ------>	100
From 1 to 5:			
CORE1, CORE3, CORE6, CORE7, CORE9a-CORE9h, CORE13a-CORE13f, CORE58, CORE59, CORE60, CORE61a-CORE61h	NEW = (CORE - 1) x 25	1 ------>	0
		2 ------>	25
		3 ------>	50
		4 ------>	75
		5 ------>	100
From 1 to 6:			
CORE2, CORE5, CORE8a-CORE8k, CORE20-CORE57, CORE62a-CORE62i	NEW = (CORE - 1) x 20	1 ------>	0
		2 ------>	20
		3 ------>	40
		4 ------>	60
		5 ------>	80
		6 ------>	100
From 0 to 5:			
CORE11, CORE12	NEW = CORE x 20	0 ------>	0
		1 ------>	20
		2 ------>	40
		3 ------>	60
		4 ------>	80
		5 ------>	100
From 0 to 20:			
CORE14, CORE15	NEW = CORE x 5		

Note: NEW = Transformed item score; CORE = original item score (recoded when necessary to have high score equal good health).

score only one concept (i.e., the same item is not used to score different concepts). It is not necessary to standardize items or to weight them. Table 5 lists the items averaged together to create each scale.

Sometimes respondents leave one or more items blank in a scale. For example, 2 percent of patients 18-44 years old missed only 1 of the 10 core physical functioning

items at baseline of the MOS (Sherbourne & Meredith, 1992; also see “Data Quality of MOS Measures” below). The rate of missing data tends to increase with age; 12 percent of patients

Table 5

DERIVING SCALES

CONCEPTUAL AREA Scale/Index	NUMBER OF ITEMS	After recoding per Tables 2 and 3, and transforming per Table 4, average the following items:
PHYSICAL HEALTH		
Physical Functioning	10	CORE4a-CORE4j
Satisfaction with Physical Ability	1	CORE5
Mobility	2	CORE6, CORE7
Effects of Pain	6	RCORE13a-RCORE13f
Pain Severity	5	RCORE2, RCORE11, RCORE12, RCORE 14, RCORE 15
Pain (RAND Scoring)	2*	RCORE2, RCORE13d
Pain (SF-36™ Scoring)	2	RCCORE2, RCCORE13d
Role Limitations Due to Physical Health	7	CORE16a-CORE16g
SF-36™ Role Limitations Due to Physical Health	4	CORE16b, CORE16c, CORE 16e, CORE16f
MENTAL HEALTH		
Cognitive Functioning	6	CORE23, CORE28, CORE32, CORE40, CORE49, CORE56
Mental Health Index I	32	RCORE20, RCORE21, CORE22, RCORE24, RCORE25, RCORE26, CORE27, CORE29, CORE30, RCORE31, CORE33, RCORE34, RCORE35, CORE36-CORE39, RCORE41, CORE42, RCORE43, CORE44-CORE48, CORE50, RCORE51, CORE52, CORE53, RCORE54, CORE55, CORE57
Psychological Distress I	22	CORE22, CORE27, CORE29, CORE30, RCORE31, CORE33, RCORE35, CORE36-CORE39, CORE42, CORE44-CORE48, CORE50, CORE52, CORE53, CORE55, CORE57

Depression/Behavioral Emotional Control I	13	CORE22, CORE29, RCORE31, CORE33, RCORE35, CORE36, CORE37, CORE39, CORE44, CORE45, CORE47, CORE53, CORE55
Anxiety I	6	CORE27, CORE30, CORE42, CORE46, CORE48, CORE52
Psychological Well-Being I	10	RCORE20, RCORE21, RCORE24-RCORE26, RCORE34, RCORE41, RCORE43, RCORE51, RCORE54
Positive Affect I	7	RCORE20, RCORE24, RCORE25, RCORE34 RCORE43, RCORE51, RCORE54
Feelings of Belonging	3	RCORE21, RCORE26, RCORE41

Table 5 continued

CONCEPTUAL AREA Scale/Index	NUMBER OF ITEMS	After recoding per Tables 2 and 3, and transforming per Table 4, average the following items:
Mental Health Index II	17	RCORE25, RCORE26, CORE27, CORE29, CORE30, RCORE31, CORE33, RCORE34, RCORE35, CORE36, CORE44, CORE46, CORE47, CORE50, RCORE51, CORE53, RCORE54
Psychological Distress II	12	CORE27, CORE29, CORE30, RCORE31, CORE33, RCORE35, CORE36, CORE44, CORE46, CORE47, CORE50, CORE53
Depression/Behavioral Emotional Control II	8	CORE29, CORE36, CORE47, CORE53, RCORE31, CORE33, RCORE35, CORE44
Anxiety II	3	CORE27, CORE30, CORE46
Psychological Well-Being II	5	RCORE25, RCORE26, RCORE34, RCORE51, RCORE54
Positive Affect II	4	RCORE26, RCORE34, RCORE51, RCORE54
Mental Health Index III	5	CORE26, RCORE34, CORE36, CORE44, RCORE51
Role Limitations Due to EmotionalProblems	3	CORE17a-CORE17c
GENERAL HEALTH		
Energy/Fatigue	5	CORE8a, RCORE8c, RCORE8e, RCORE8g, CORE8i
SF-36™ Vitality	4	CORE8a, RCORE8c, RCORE8e, CORE8i
Sleep Problems I	9	CORE62a, RCORE62b, CORE62c, CORE62d, CORE62e, CORE62f, CORE62g, CORE62h, RCORE62i
Sleep Problems II	6	RCORE62b, CORE62c, CORE62e, CORE62f, CORE62g, RCORE62i
Physical/Psychophysiologic Symptoms	8	RCORE9a-RCORE9h
Social Activity Limitations Due to Health	4	RCORE3, CORE58-CORE60
SF-36™ Social Functioning	2	RCORE3, CORE58
Role Functioning: Able to Work	1	CORE19

Role Functioning: Able to Do Housework	1	CORE18

Table 5 continued

CONCEPTUAL AREA Scale/Index	NUMBER OF ITEMS	After recoding per Tables 2 and 3, and transforming per Table 4, average the following items:
General Health Perceptions:		
Current Health	7	RCCORE1, CORE61a, RCORE61b, CORE61c, CORE61d, RCORE61e, RCORE61f
General Health (RAND Scoring)	5*	RCORE1, RCORE61e, RCORE61f,CORE61g, CORE61h
General Health (SF-36™ Scoring)	5	RCCORE1, RCORE61e, RCORE61f, CORE61g, CORE61h
SF-20 Current Health	5	CORE1, CORE61a, CORE61c, RCORE613, RCORE61f
Health Distress	6	CORE8b, CORE8d, CORE8f, CORE8h, CORE8j, CORE8k

Notes:

1. *Indicates items used for RAND 36-Item Health Survey 1.0 scoring procedure.
2. "RCORE" indicates that the item was reversed; "RCCORE" indicates that the item was reversed and recalibrated.

75 and older had missing data for 1 of the 10 physical functioning items. One advantage of multi-item scales is that a scale score can be estimated as long as the respondent has answered at least one item in the scale. In the initial phases of the MOS, we assigned a scale score as missing if more than half of the items in a given scale were missing. This was a conservative approach, and others may want to assign a scale score based on having any nonmissing data (e.g., the presence of only one item in a given scale). We recommend substituting a person-specific estimate of the missing score for any missing items. The item average for each scale can be imputed by averaging together all nonmissing responses for each respondent separately. The SAS_ statements shown in Appendix B under the heading "Step 5: Deriving Scales" use this imputation strategy. This missing data procedure is reasonable because the average of responses to nonmissing items for the MOS core measures is a good estimate of the missing response, as supported by excellent item convergence (i.e., item-scale correlations, corrected for item overlap) for the MOS multi-item scales (Stewart, Sherbourne, Hays et al., 1992). However, biased item estimates can occur using this method even with large item-scale correlations. More sophisticated missing data imputation strategies, such as regression

estimates (Raymond, 1986) can be implemented using some existing software packages (e.g., STATA, 1992).