# The Swiss Transplant Cohort Study's framework for assessing lifelong psychosocial factors in solid-organ transplants

**Background**—Understanding outcomes after transplant requires a biopsychosocial model that includes biomedical and psychosocial factors. The latter, to date, are assessed only in a limited way as part of transplant registries or cohort studies. The Swiss Transplant Cohort Study (STCS) is a nationwide open cohort study (starting May 2008) to systematically and prospectively assess psychosocial factors. This article describes the framework underpinning STCS's psychosocial assessment.
**Methods**—The STCS framework was adapted from the multidimensional conceptual perspective of Dew et al to describe transplant psychosocial domains and specific outcomes by adding a time perspective, a system perspective, and interaction among domains.
**Results**—We propose a multidimensional, multilevel biopsychosocial framework representing mutually influencing domains from before to after transplant, and exemplify each domain by factors included in STCS and their measurement. The transplant patient, centrally positioned, is described by clinical and sociodemographic characteristics (eg, socioeconomic status, educational, professional, and relationship status). The following psychosocial domains further describe the patient: (1) physical/functional (eg, perceived health status, sleep quality, daytime sleepiness), (2) psychological (eg, depression, stress), (3) behavioral (eg, medication adherence, smoking, drug use, physical activity, sun protection), (4) social (eg, work capacity/ return to work), and (5) global quality of life. Factors associated with health care system level (eg, trust in transplant team) are also included in the model.
**Conclusion**—The STCS's psychosocial framework provides a basis for studying the interplay of biomedical, sociodemographic, psychosocial, behavioral, and health care system factors in view of transplant outcomes and therefore has the potential to guide biopsychosocial transplant research. (*Progress in Transplantation.* 2013; 23:235-246)

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Transplant outcomes are influenced by interplay of biomedical, behavioral, psychosocial, and sociodemographic factors as well as system factors such as practice patterns in transplant centers and characteristics of transplant clinicians.[1-5]

Although the scientific basis for biomedical outcomes after solid-organ transplant is significantly fueled through data generated by registries and large cohort studies, the evidence base of psychosocial outcomes is weaker both in volume and in view of methodological
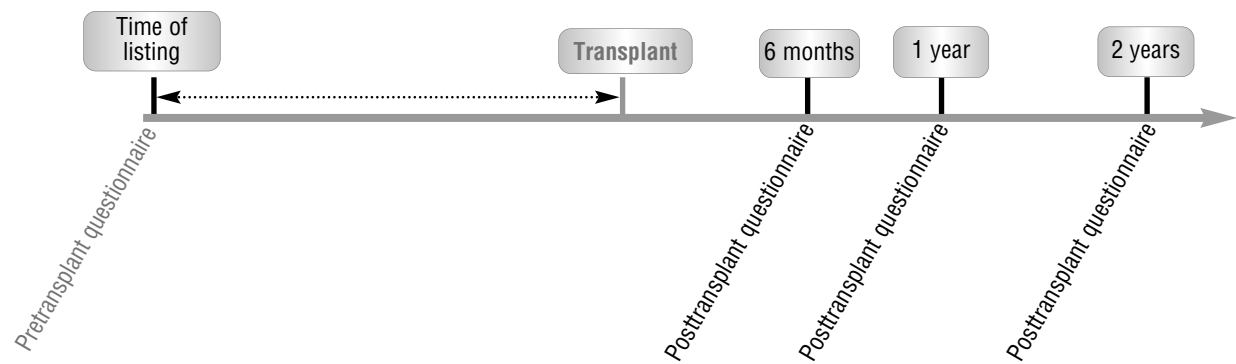
Figure 1 Design of the psychosocial data collection of the Swiss Transplant Cohort Study.

quality.[1] Psychosocial outcomes encompass recipients' physical, functional, and psychological status; behavioral management of their medical regimen; social functioning; and perceptions of global quality of life (QOL).[1]

Transplant registries and large cohort studies provide the necessary research framework to describe characteristics of transplant populations, to report clinical and psychosocial outcomes, and to explore specific risk factors that influence these outcomes. Yet, psychosocial and behavioral variables have been assessed in only a limited manner or not at all in transplant registries and large transplant cohort studies (eg, US Renal Data System, United Network for Organ Sharing, European Liver Transplant Registry, International Society for Heart and Lung Transplantation registry). These factors, however, cannot be discarded or neglected given the increasing evidence demonstrating that selected psychosocial factors are independent risk factors for poor outcome after transplant.[1-5]

Psychosocial variables therefore must be included in outcomes research and comparative effectiveness research for which cohort studies are an ideal instrument,[6] also in transplant. Moving from the prevailing biomedical model toward a biopsychosocial model[7] in transplant research including not only biomedical factors, yet also acknowledging the importance of psychosocial factors to comprehensively gain knowledge about risk factors and outcomes in transplant is crucial to move the field forward.

## The Swiss Transplant Cohort Study

The Swiss Transplant Cohort Study (STCS), a nationwide cohort study that started May 2, 2008, includes all solid-organ transplant patients who received transplants in the 6 Swiss transplant centers.[8] The STCS performs a comprehensive data collection from before transplant to lifelong after transplant. In addition to a broad set of clinical data, the STCS has a specific focus on infectious disease development, biobanking, and psychosocial and behavioral factors, making the STCS to our knowledge the most comprehensive cohort study worldwide in transplantation.

Patients are invited to participate in the STCS before transplant, and data collection is started after written informed consent is provided. About 93% of transplant patients agree to participate. Data are collected by the local STCS data manager of the transplant center where the patient is followed up. All collected data are transferred to a centrally managed database and securely stored. A total of 1833 transplant patients (1045 single kidney, 355 liver, 182 lung, 133 heart, 20 islet, 7 pancreas, 1 small bowel, and 90 combined transplants) have been enrolled in the STCS between May 2, 2008, and December 4, 2012. This article is focused specifically on the psychosocial data collection of the STCS, and Figure 1 shows the data collection points for the STCS's psychosocial assessment.

The aim of this article is therefore to discuss the STCS's biopsychosocial framework that underpins its psychosocial data collection and measurement. We exemplify the model's value in categorizing relevant factors that are meaningful to be included in psychosocial data collection primarily because of their predictive value for outcome.

## An Expanded Biopsychosocial Framework for Transplant Research

The STCS's biopsychosocial framework was developed starting from the multidimensional conceptual perspective of Dew et al[1,9] to describe transplant psychosocial domains and specific outcomes. The original model of Dew et al positioned the transplant (inner circle) centrally surrounded by a number of circles that represent specific psychosocial domains. They stated that the transplant is associated with a series of psychosocial effects that extend through key domains of patients' lives. More specifically, Dew et al highlighted 5 domains: (1) physical/functional, (2) psychological, (3) behavioral, (4) social, and (5) global QOL.

We adapted the model of Dew et al[9] (Figure 2) in several ways by (1) adding a timeline that represents the transplant journey from before to lifelong after transplant, (2) by integrating a systems perspective (ie, patient, health care provider, health care organization,
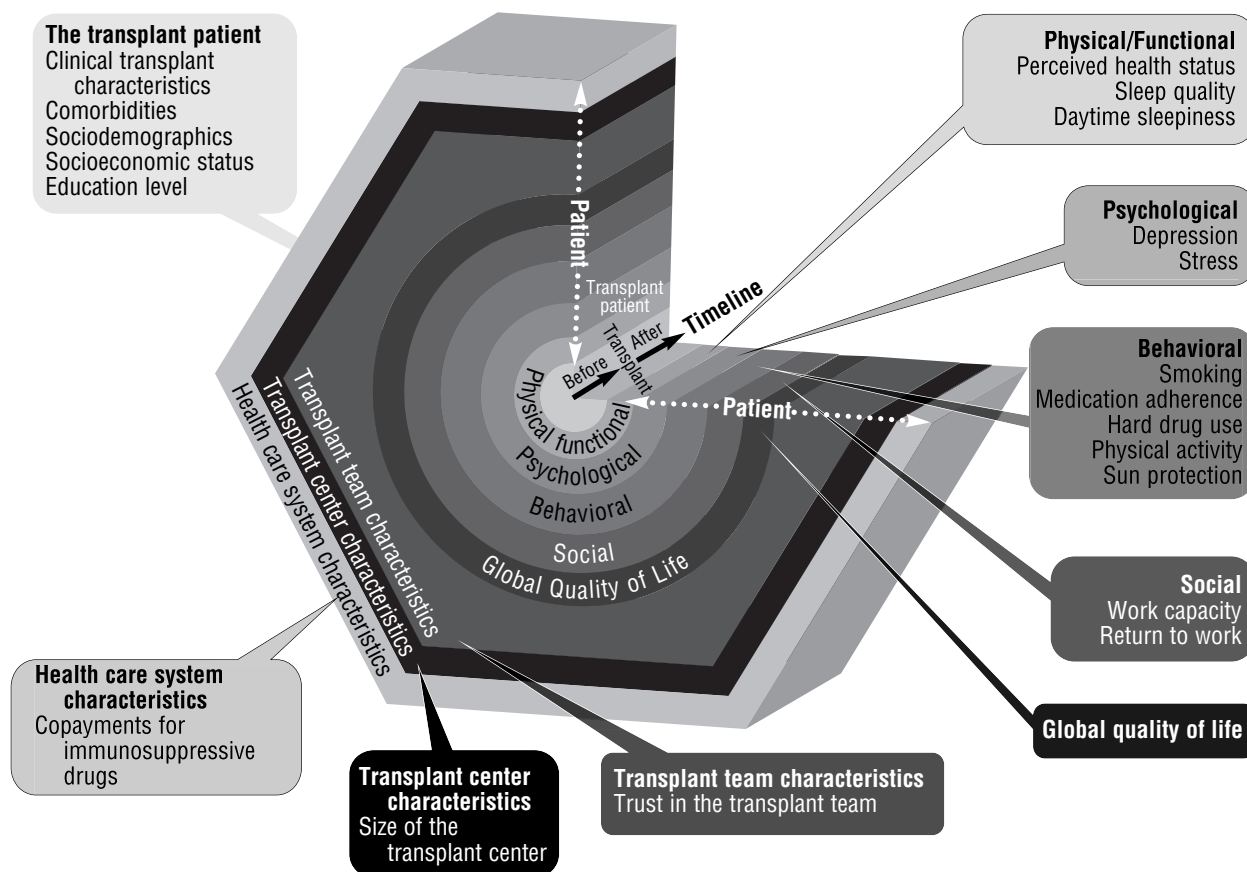
**The transplant patient**
Clinical transplant
   characteristics
Comorbidities
Sociodemographics
Socioeconomic status
Education level

**Physical/Functional**
Perceived health status
Sleep quality
Daytime sleepiness

**Psychological**
Depression
Stress

**Behavioral**
Smoking
Medication adherence
Hard drug use
Physical activity
Sun protection

**Social**
Work capacity
Return to work

**Global quality of life**

**Health care system
   characteristics**
Copayments for
   immunosuppressive
   drugs

**Transplant center
   characteristics**
Size of the
   transplant center

**Transplant team characteristics**
Trust in the transplant team

Figure 2 Framework for assessing lifelong psychosocial factors in solid-organ transplant in the Swiss Transplant Cohort Study.
Adapted from Dew et al,[9] with permission.

and health care system level), and (3) suggesting the possible interaction between the different domains included in the model.

More specifically, we added a time dimension representing the transplant journey from before transplant to lifelong after transplant, thus adding a 3-dimensional perspective to our framework, acknowledging that a patient's status varies over time and results from a dynamic interplay of biomedical and psychosocial factors.[10] Outcomes are also influenced by higher system level factors beyond the patient level,[11,12] so we added a broader ecological systems perspective,[13,14] consisting of 3 levels (hexagons), namely, the transplant team, the transplant center, and the health care system, reflecting their potential influence on clinical and psychosocial domains.[11,12] The framework moreover implies interaction between the different domains, emphasizing the interplay between the system factors, the psychosocial domains, and inner circle of transplant patients' sociodemographic and clinical characteristics.

Patients' behavior is influenced not only by characteristics of the individual patient (eg, socioeconomic

status, living situation, comorbid conditions) but also by the system where the patient lives and receives health care, so-called system factors.[14] System factors comprise elements beyond the patient that interact with patients' characteristics to influence patients' behavior.[14] System factors can be classified as health care provider, health care organization, and health care system factors.[14] An example of a system factor at the health care provider level is trust in the health care provider. A number of studies have shown that patients with higher levels of trust in their health care provider are more likely to adhere to recommended health behaviors such as medication adherence.[15] An example of the interaction between a factor at the system level and a characteristic of a patient that could influence clinical outcomes after transplant is the interaction between trust in the physician and a patient's perceptions related to treatment effectiveness.[15] Patients with greater trust in their physicians are more likely to believe that the treatment prescribed by the physician will be beneficial and consequently may be more adherent to treatment recommendations, leading to better clinical outcomes. Factors at the health care organization

level are for instance the size of the transplant center or the skill mix of the transplant team.[14] Another example that illustrates the influence of system factors on the patient is the extent to which immunosuppressive costs are covered by the health care system.[14] In the United States, Medicare currently covers the cost of immunosuppressive medications for kidney transplant recipients for 3 years after transplant.[16] For patients, in particular those with limited economic resources, loss of Medicare coverage after 3 years may adversely affect the ability to purchase these medications and consequently increase nonadherence and adversely affect graft survival. A change in the health care policy that would provide lifelong coverage of immunosuppressive drugs for kidney transplant recipients in the United States, a measure that would have the potential to decrease costs related to nonadherence,[17,18] might improve transplant clinical outcomes.

The equal distance between circles representing the psychosocial domains in Figure 2 does not imply that they are equally important because their significance might vary over time. Indeed, the influence and interaction of specific psychosocial variables on specific outcomes or vice versa can vary in the pretransplant phase, the acute posttransplant phase, or in the long term after transplant. For instance, during the pretransplant period, the life-threatening end-stage organ disease might be the predominant factor that influences a patient's psychosocial and clinical outcomes, whereas a patient facing cancer treatment 7 years after transplant might view the cancer experience to be the driving factor influencing his/her psychosocial functioning at that moment. Another example is that of a kidney transplant patient who gets divorced and subsequently suffers from depression, making the patient more prone for medication nonadherence[19,20] and therefore also for graft failure.[5] A last example is lung transplant patients who increase their physical exercise and subsequently benefit from this change in health-related QOL.[21] These examples illustrate the multiple pathways and interactions implied by our framework that can result in changes of clinical or psychosocial outcomes over time during the transplant journey.

## Operationalization of the STCS Biopsychosocial Model

The domains of the STCS framework can be further operationalized by assessing factors in each domain. Without being exhaustive, we provide examples for further operationalization of the domains from factors we chose to include in the data collection for the STCS as they have predictive power for clinical outcome in transplant recipients and other chronically ill patients or are emerging as relevant factors to be included in psychosocial assessment.

Sociodemographic factors linked to the transplant patient (center of circle) include a combination of sociological and demographic characteristics. Examples of sociodemographic factors that can be included in this domain are socioeconomic status, educational level, relationship status, and professional status.[3,22-24] Factors that can be included in the physical/functional domain are perceived health status, sleep quality,[25-27] and daytime sleepiness.[28] Depression and stress are examples of variables that can be used to operationalize the psychological domain.[1,2,29-32] The behavioral domain in our framework can be operationalized by, for example, medication adherence,[33] smoking,[34-36] hard drug use,[37,38] physical activity,[39-41] and sun protection.[42] Examples of factors that can be included in the social domain are work capacity and return to work.[43,44] The domain of global QOL is the last element of the patient level in the STCS model and expresses a patient's general well-being, a summary of general health, physical functioning, role limitation due to physical health problems, bodily pain, vitality, social functioning, role limitation due to emotional problems, and general mental health.[45] System factors are the last set of factors in the STCS's biopsychosocial model. Here we included for instance trust in the transplant team[46,47] or access to care or copayments for immunosuppressive drugs.[14,17,48,49]

The Table summarizes the measurement of the different psychosocial factors included in the STCS. The choice of the measures was driven by several intertwined priorities and considerations. First, a limiting factor in the development of the psychosocial questionnaire was the concern for subject burden and the request of the scientific committee of the STCS to limit the number of items for the collection of psychosocial data. Second, we wanted to opt for measures with established validity and reliability or measures for which validated translations in English, German, French, and Italian existed. Third, we searched for measures to assess sociodemographic variables in Swiss national surveys to guarantee appropriate assessment of these factors for the Swiss context (for which we know that quality is being continuously monitored by the Swiss Federal Statistical Office). Guided by these 3 elements, we determined measures for each of our selected variables that combined constituted the STCS's Psychosocial Questionnaire (see also Koller et al[8]). The Table provides information on each variable's measurement, its scoring, and the available validity and reliability information.

Perceived health status (EQ5D, EQVAS) and depressive symptoms (Depression scale of the Hospital Anxiety and Depression Scale) are measured with validated measures that exist in the 4 languages used in the STCS. Socioeconomic status, educational level, relationship status, and professional status are measured

Table  Assessment of variables: Swiss Transplant Cohort Study (STCS)–Psychosocial Questionnaire

| Variable | Measurement, scoring, validity, and reliability information | |
|---|---|---|
| **Sociodemographic** | | |
| Socioeconomic status<br>Swiss Health Survey | What is the **current** available monthly budget (after tax deductions) of your household?<br>☐ Less than SwF 4500<br>☐ Between SwF 4501 and 6000<br>☐ Between SwF 6001 and 9000<br>☐ More than SwF 9001<br>☐ I do not want to answer | Ongoing data quality controls concerning item clarity and validity are done by Swiss Federal Statistical Office (SFSO)[50] |
| Educational level<br>Swiss Health Survey | ☐ No completed school or professional education (less than 9 formation years)<br>☐ Mandatory school (primary/secondary/junior high/district school) (9 formation years)<br>☐ Apprenticeship or full-time vocational school (10-13 formation years)<br>☐ Diploma qualifying for university admission (Matura) (13 formation years)<br>☐ Higher professional education (eg, master craftsman diploma, federal diploma) (14-16 formation years)<br>☐ Higher technical or commercial school (eg, school for social work, school for engineering) (14-18 formation years)<br>☐ University degree (eg, bachelor or master of science) (16 or more formation years)<br>☐ Other: _____<br>☐ I do not want to answer | Ongoing data quality controls concerning item clarity and validity are done by SFSO[50] |
| Relationship status<br>Swiss Health Survey | What is your **current** status?<br>☐ Single<br>☐ Married/Stable partnership/Cohabitation<br>☐ Widow/Widower<br>☐ Divorced/Dissolved partnership/Separated<br>☐ I do not want to answer | Ongoing data quality controls concerning item clarity and validity are done by SFSO[50] |
| Professional status<br>Derived from Swiss Health Survey and Kidney Disease and Quality of Life Short Form (KDQOL-SF)[51] | Please specify your **current primary** occupation.<br>☐ Self-employed (eg, own company, freelance)<br>☐ Working in a relative's firm or business<br>☐ Apprentice, trainee (eg, with training contract)<br>☐ Director, manager, procurator<br>☐ Middle/lower management (eg, office manager, branch manager)<br>☐ Employee in another function (eg, staff, blue-collar worker)<br>☐ Houseman/housewife in your own home<br>☐ Student, scholar<br>☐ Retirement pensioner<br>☐ Invalid pensioner<br>☐ Other: _____<br>☐ I do not want to answer | Ongoing data quality controls concerning item clarity and validity are done by KDQOL-SF.[51] |
| **Physical/Functional** | | |
| Perceived health status<br>www.euroqol.org | • The Euroqol 5-D (EQ-5D)[52]<br>• Five dimensions: mobility, self-care, usual activities, pain/discomfort, and anxiety/depression → 3 levels of severity (no, some, and severe problems), theoretically allowing for 243 (35) different health states<br>• Visual Analog Scale (VAS): "worst imaginable health state" (=0) to "best imaginable health state"(=100) | EQ-5D[52]: criterion-related and construct validity in liver transplant candidates and recipients[53]<br>Test-retest reliability[54] and the construct validity and concurrent validity of the EQ-5D with the SF-36 in a kidney transplant population[55] |

*Continued*

by standard items for the Swiss setting as put forward by the Swiss Federal Statistics Office. Smoking, hard drug use, working capacity, and return to work are assessed by single items derived from the Swiss HIV Cohort Study. For medication adherence, physical exercise, sun protection, sleep quality, daytime sleepiness, stress, global QOL, and trust in the transplant team, measures were derived from published papers

Table *Continued*

| Variable | Measurement, scoring, validity, and reliability information | |
|---|---|---|
| **Physical/Functional** | | |
| Sleep quality | Sleep quality<br><br>On a scale from 0 to 10, how would you rate your sleep quality overall in the past 4 weeks?<br><br>Very poor             Very good<br>0  1  2  3  4  5  6  7  8  9  10<br>☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ | Sleep quality item[26]:<br>• Item derived from the KDQOL-SF[51]<br>• Poor sleep quality cutoff: <6[26]<br>• Predictive validity for mortality in dialysis patients[26]<br>• Content validity based on content validity index is good (0.81)<br>• Concurrent validity: Association with Pittsburgh Sleep Quality Index ($\rho$: -.737, $P < .01$)[56] |
| Daytime sleepiness | Daytime sleepiness adapted from the sleep quality item[26]<br><br>On a scale from 0 to 10, how would you rate your day-time sleepiness overall in the past 4 weeks?<br><br>Not at all sleepy        Very sleepy<br>0  1  2  3  4  5  6  7  8  9  10<br>☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ | Daytime sleepiness item[57]:<br>• Adapted from Elder et al[26] and a VAS Sleepiness Scale[58]<br>• Daytime Sleepiness cutoff >4[57]<br>• Concurrent validity: Association with Epworth Sleepiness Scale ($\rho$: .531, $P < .01$)[57]<br>• Convergent validity with Depression Anxiety and Stress scale ($\rho$: .235, $P < .01$)[57]<br>• Group difference validity with depressive symptomatology, showed increasing odds.[57] |
| **Behavioral** | | |
| Medication adherence; Swiss HIV Cohort Study[59,60] | Two items of the Basel Assessment of Adherence to Immunosuppressive Medications Scale (BAASIS)[61] (taking adherence and drug holidays)<br><br>**Before transplant**<br>Taking medication regularly can be challenging. Therefore, we would like to ask you the following questions about your medication-taking behavior.<br>How often did you miss a dose of your medication in the **past 4 weeks**?<br><br>☐ Never<br>☐ Once a month<br>☐ Once every 2 weeks<br>☐ Once a week<br>☐ More than once a week<br>☐ Every day<br><br>Did you miss more than 1 consecutive dose of your medication in the past **4 weeks**?<br>☐ Yes<br>☐ No<br><br>**After transplant**<br>Taking medication regularly can be challenging. Therefore, we would like to ask you the following questions about your medication-taking behavior.<br>How often did you miss a dose of your immunosuppressive medication (eg, Prograf, CellCept/Myfortic, Rapamune, Certican, Neoral) in the **past 4 weeks**?<br><br>☐ Never<br>☐ Once a month<br>☐ Once every 2 weeks<br>☐ Once a week<br>☐ More than once a week<br>☐ Every day<br><br>Did you miss more than 1 consecutive dose of your immunosuppressive medication in the **past 4 weeks**?<br>☐ Yes<br>☐ No | Taking adherence item[61]: Concurrent validity relative to electronic monitoring in human immunodeficiency virus (HIV) population.[59,60]<br>Sensitivity: 87.5% and specificity: 78.6%, using virologic failure as gold standard in HIV[62]<br>Predictive validity in view of viral rebound in HIV population[60] |

*Continued*

Table *Continued*

| Variable | Measurement, scoring, validity, and reliability information | |
|---|---|---|
| **Behavioral** | | |
| Smoking<br>  Swiss HIV Cohort Study[63] | Do you smoke?<br>  ☐ Yes<br>  ☐ No, I stopped **less** than 1 year ago<br>  ☐ No, I stopped **more** than 1 year ago<br>  ☐ No, I never smoked<br>  ☐ I do not want to answer | Item of Swiss HIV Cohort Study[50,63]<br>No further information on psychometric properties available at current time |
| Hard drug use<br>  Swiss HIV Cohort Study[63] | Do you consume hard drugs (eg, heroin, cocaine)?<br>  ☐ Yes<br>  ☐ I stopped consuming hard drugs **less** than 1 year ago<br>  ☐ I stopped consuming hard drugs **more** than 1 year ago<br>  ☐ I never consumed hard drugs<br>  ☐ I do not want to answer | Adapted item of Swiss HIV Cohort Study[50,63]<br>No further information on psychometric properties available at current time |
| Physical exercise and Surgeon General's Report on Physical Activity and Health | Do you participate in regular physical activity (eg, walking, cycling, cleaning the house, yard work)?<br>  ☐ Yes<br>  ☐ No<br><br>If yes<br>  How many days per week? ___days<br>  How many minutes per session on average? ___minutes<br><br>How hard do you exert yourself during your physical activity?<br>  ☐ Very easy<br>  ☐ Easy<br>  ☐ Somewhat hard<br>  ☐ Hard<br>  ☐ Very hard | Physical exercise[41,64,65]: Validation study in progress of the 2 items vs objective measurement of physical activity with accelerometer (unpublished data, Schmidt-Trucksäss et al, University of Basel, Switzerland) |
| Sun protection[66] | Occupational sun exposure. In the summer, on average, how many hours are you outside per day between 10 AM and 4 PM on weekdays (Monday-Friday)?<br>  ☐ 30 minutes or less<br>  ☐ 31 minutes to 1 hour<br>  ☐ 2 hours<br>  ☐ 3 hours<br>  ☐ 4 hours<br>  ☐ 5 hours<br>  ☐ 6 hours<br><br>Sun exposure during leisure time. In the summer, on average, how many hours are you outside per day between 10 AM and 4 PM on weekend days (Saturday and Sunday)?<br>  ☐ 30 minutes or less<br>  ☐ 31 minutes to 1 hour<br>  ☐ 2 hours<br>  ☐ 3 hours<br>  ☐ 4 hours<br>  ☐ 5 hours<br>  ☐ 6 hours<br><br>Sun-protection behavior. How often do you wear sunscreen?<br>  ☐ Never<br>  ☐ Rarely<br>  ☐ Sometimes<br>  ☐ Often<br>  ☐ Always<br><br>Sun-protection behavior. How often do you wear a hat?<br>  ☐ Never<br>  ☐ Rarely<br>  ☐ Sometimes<br>  ☐ Often<br>  ☐ Always | • Sun exposure and sun protection practices are assessed by 4 items selected by dermatology and transplant experts from a 14-item core set recommended by Glanz et al[66]<br>• Single-item scoring<br>• Content validity was ensured by cognitive interviews with patients and by opinion of an expert panel |

*Continued*

Table *Continued*

| Variable | Measurement, scoring, validity, and reliability information | |
|---|---|---|
| **Psychological** | | |
| Depressive symptoms | Depression scale of the Hospital Anxiety and Depression Scale (HADS-D) | Reliability of the German version of the HADS-D is good.[67] The HADS-D[68] has been well validated as a screening instrument in different populations of patients including transplant recipients.[68-74] |
| Stress | Stress means a situation in which a person feels tense, restless, nervous, or anxious or is unable to sleep at night because his/her mind is troubled all the time: Do you feel this kind of stress these days? On a scale from 0 to 5, how would you rate this kind of stress these days?<br><br>Not at all stressed · Only a little stressed · To some extent stressed · Rather much stressed · Very much stressed<br>1   2   3   4   5 | The 1-item evaluation of stress was developed and validated in the occupational research context, was found a valid measure of well-being and converged with psychological variables and sleep disturbances[75] |
| **Social** | | |
| Working capacity/ Return to work, Swiss HIV Cohort Study | Before transplant (the past 6 months)<br><br>Please specify your **average** working/earning capacity during the past 6 months. 100% equals full-time workload.<br>☐ More than 80% workload<br>☐ Between 51% and 80% workload<br>☐ Between 21% and 50% workload<br>☐ Between 1% and 20% workload<br>☐ 0% workload<br>☐ I do not want to answer<br><br>If 0% working capacity, please indicate the main reason:<br>☐ Houseman/housewife in your own home<br>☐ In education<br>☐ Retirement pensioner<br>☐ Illness<br>☐ Unemployed<br>☐ Invalid pensioner<br>☐ Other reason:_____<br>☐ I do not want to answer | Item derived from the Swiss HIV Cohort Study.[76] Working capacity is defined as the percentage of time spent in professional activity during the past 6 months (pretransplant assessment) or after transplant (6 months posttransplant assessment), or in past year (yearly assessment). Working capacity is assessed at all time points of the Swiss Transplant Cohort Study data collection. Return to work can be derived from working capacity. |
| **Global quality of life** | | |
| Quality of life<br><br>System | Please mark the line below at the place that best reflects your situation of the **past week**. The more your situation was close to perfect quality of life, the further you place the mark to the right. The more your situation was close to worst imaginable quality of life, the further you place the mark to the left.<br><br>Worst imagineable quality of life      Perfect quality of life<br>├·········· 10 cm ··········┤ | • VAS ranging from 0 to 100.[45]<br>• QOL-VAS was psychometrically tested in a sample of cancer patients.[45]<br>• Multitrait-multimethod correlation analysis showed a high convergent validity with the Medical Outcome Survey SF20 (MOS SF-20) ($r = 0.70$) and the Rotterdam Symptom Checklist (RSCL) ($r = 0.72$).<br>• Correlations with subscales of the MOS SF-20 and RSCL were moderate to high, ranging from $r = 0.29-0.70$.<br>• The test-retest reliability intraclass correlation for the VAS was 0.87.<br>• Distribution-based responsiveness was moderate for the VAS (standardized response mean: -0.47; effect size: -0.56).<br>• Anchor-based responsiveness was highest for the VAS ($r = 0.54$). |

*Continued*

Table *Continued*

| Variable | Measurement, scoring, validity, and reliability information | |
|---|---|---|
| **System** | | |
| Trust in the transplant team | How much do you trust your transplant team, where 0 is "not at all" and 10 is "completely"?<br><br>Not at all             Completely<br><br>0   1   2   3   4   5   6   7   8   9   10<br>☐   ☐   ☐   ☐   ☐   ☐   ☐   ☐   ☐   ☐   ☐ | • Trust in the transplant team is assessed by a single item adapted from an item used in a HIV cohort study.[77]<br>• Patients rate their trust in the transplant team on 10-point scale ranging from not at all (0) to completely (10).<br>• To examine construct validity of the single item, Saha et al[77] examined the association between race and trust with and without adjustment for patient-provider interaction quality. There was a significant association between race and trust, adjusting did not change this association (with adjustment: $\beta= -0.63$, 95% CI= -0.88, -0.39; without adjustment: $\beta= -0.66$, 95% CI= -0.92, -0.41) |

that proposed single or limited numbers of items measures and for which some validity or reliability information was available.[8,26,41,45,50-56,58-60,62-73,75-80] As admittedly not all measures were fully validated at the start of the data collection with the STCS, separate validation projects for some of the measures (eg, daytime sleepiness, physical activity) have been launched. For those items for which not all language versions were available, we did a back and forward translation by native speakers.

## Discussion

This article described an expansion of a biopsychosocial framework developed by Dew et al[1,9] for assessing psychosocial outcomes in transplant recipients. We extended this existing framework in the realm of the psychosocial data collection of the Swiss Transplant Cohort Study, a nationwide cohort study including all patients undergoing transplant in Switzerland from before the transplant to lifelong after the transplant. The STCS is the only large cohort and/or registry we know of that includes a set of psychosocial factors in lifelong follow-up, making this cohort a rather promising research instrument for psychosocial transplant-related outcomes research.

Indeed, transplant is associated with chronic illness[33] and outcomes in chronically ill persons are determined by more than just biomedical factors. It can be hypothesized that the lack of improvement of long-term survival in solid-organ transplant recipients[81] is also related to psychosocial and behavioral issues. Increasing evidence shows that specific psychosocial, behavioral, and system factors play a role

as independent determinants of clinical outcome in chronically ill patients, including transplant recipients. Therefore, embracing a biopsychosocial perspective is a crucial way forward in unraveling potential pathways to improve long-term outcome after transplant.[33]

We expanded and refined the transplant psychosocial outcome model of Dew et al[1,9] by (1) adding a time perspective reflecting the transplant journey from before to after transplant, (2) adopting an ecological perspective by highlighting the importance of also focusing on the system in which the transplant patient is treated, and (3) explicitly highlighting the dynamic interplay between domains included in our framework. We gave a number of examples of how the different proposed domains in the STCS biopsychosocial framework might be further operationalized. Admittedly, the proposed list of variables is not comprehensive and more variables might be added to the respective domains of the STCS framework in the future.

The proposed framework that guides the STCS's psychosocial data collection certainly does not define the hypothesized pathways of how different factors influence one another, how they interact, and how they are ultimately related to clinical outcome. An end-point model that describes these relationships and hypothesized causal pathways is in preparation (De Geest et al, B-SERIOUS project, work in progress).

A further option for strengthening the model in the future would be the inclusion of the perspective emerging from published research on transplant and chronically ill patients about how bundles of factors affect clinical outcome. An example is the social adaptability index, which is based on a combination score of

employment, marital status, education, income, and substance abuse predicting clinical outcome in kidney transplant.[3]

The measurement of the factors included in the STCS's psychosocial framework are based on established validated instruments as well as single items derived from registries or large population-based studies.[1-3,22-27,29-42,45-47] Admittedly, in a nationwide cohort study, we need to keep the balance between subject burden and valid assessment, and therefore not all factors can be measured with a multitude of items.

Despite the fact, as just indicated, that the developed framework guiding the STCS's psychosocial assessment can be further advanced and fine-tuned both in number of factors included and their measurement, the STCS framework exemplifies the underlying rationale and provides a unique basis for transplant outcomes research compared with other cohorts and registries. The STCS allows describing and comparing characteristics of the different transplant populations longitudinally and provides a basis for exploring single or synergistic risk factors for transplant outcomes, while controlling for relevant variables reflecting the dynamic interplay between biomedical, psychosocial, and behavioral factors in outcomes after transplant.

## Conclusion

The STCS is the first transplant cohort study we know of that has adopted a biopsychosocial perspective, thereby creating a unique research framework for outcomes research in transplantation. The STCS psychosocial data collection is based on a framework that includes not only psychosocial domains, but also includes an ecological perspective. The STCS framework therefore provides a basis for studying the complex interplay of biomedical, sociodemographic, psychosocial, and behavioral and system factors in view of transplant outcomes and therefore also has the potential to identify potential pathways to target the improvement of transplant outcomes in the future.

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