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Food safety in solid-organ transplant recipients: a single-center qualitative study

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Abstract

Infections represent an important source of morbidity and mortality in solid organ transplant recipients due to the state of immunosuppression associated with the use of anti-rejection treatments. Infection control and eviction of exposure risks is an important strategy for post-transplant management in these patients. Food-borne pathogens are one source of disease which is commonly targeted by strict guidelines on food avoidance and behaviors to adopt in order to minimize the risk of infection. However, these guidelines are not evidence-based, but are rather based on common sense, expert opinion, or knowledge of mechanisms of transmission of specific pathogens. Moreover, adherence of transplant patients to these guidelines is largely unexplored. Thus, it remains unknown if protection strategies are at all effective, or even if patients apply them in their daily lives.

In this study, we used a self-report survey approach to ask whether 197 transplant patients treated the University Hospital of Lausanne (CHUV) applied the food-associated behaviors prescribed by physicians, and whether sub-populations of patients could be differentiated by such behaviors. In particular, we asked if guideline adherence differed between recipients of different organs, or between patients at different time-points after transplantation, notably in the first year post-transplant or later. We found that over 90% of patients had consumed risk-associated food (RAF) on at least one occasion since the transplant, and that 74% reported occasional or frequent consumption of one or several RAFs. In contrast, hygiene recommendations were followed in a more reliable manner, with almost 70% reporting following them all of or most of the time. Finally, a series of hypothetical situations where participants were again tested on their general knowledge of risks associated with foods and behaviors to adopt showed that 71% of patients were unable to identify all situations where risk may be present. In general, higher levels of adherence to guidelines seemed to be associated with early post transplant period.

In conclusion, transplant recipients frequently consume risk associated food, particularly late after transplantation and they follow appropriate measures of food hygiene. Whether this behavior is associated with increase infection rates needs to be further investigated.

Introduction

Since its introduction in the second half of the 20th Century, organ transplantation has allowed the extension of the lives of millions of patients suffering from end-stage organ diseases. Over the course of time, progress in the development of technology and medication has contributed to an increase in safety and quality-of-life for transplant recipients to the point where they are now mostly able to lead almost completely normal lives. However, organ transplantation-related conditions remain a significant cause of morbidity and mortality. Graft rejection and infection, due to insufficient or excess immunosuppression respectively, are among the main causes of medical complications for most recipients.

The permanent state of immunosuppression due to the use of immunosuppressive drugs puts solid-organ transplant (SOT) recipients at a higher risk of infection as compared to the general population. They are more likely to develop common infections such as community- and hospital-acquired pneumonia, urinary tract infection or gastro-intestinal infections, and more likely to suffer reactivation of latent infections such as tuberculosis or opportunistic infections such as Pneumocystis pneumonia (1). In addition, they are exposed to risks exclusive to them, for example donor-borne infections like *Strongyloides,* cytomegalovirus and Epstein-Barr virus. The relative importance of each risk varies according to time since transplant, net level of immunosuppression, individual susceptibility and exposure to a given pathogen. Indeed, shortly after surgery, infection risks are mostly related to the surgical procedure itself and the hospital setting and include nosocomial infections of wound, catheters or aspiration pneumonia. Later after transplant, infections are more related to the state of immunosuppression and to pathogen exposure from the environment. Patients can be exposed to pathogens via other infected individuals, travel, poor hygiene and food ingestion. The question of food-borne disease is central to this study.

Food-borne pathogens are a risk for the entire population. Pathogens include *Campylobacter jejuni, Salmonella spp., Shigella,* and *Listeria* as well as parasites such as *Giardia* and viruses such as hepatitis E and A (2, 3). These agents can cause both benign and severe courses of disease, depending on patient related-factors, including immunity. Since immunocompromised patients are more susceptible to infections, SOT recipients are generally educated in basic food safety rules. These rules, drawn up by the American Society of Transplantation (AST), include eviction of foods with higher risk of contamination by pathogens (undercooked meat and fish, unpasteurized egg and milk products, certain raw vegetables) and hygiene recommendations (systematic hand hygiene, separation of raw and cooked foods in storage, cleaning of utensils after use with raw foods) (4). However, these food-safety recommendations are not evidence-based, as there is no data to show that observance of the recommendations is associated with lower morbidity or mortality. Indeed, while cases of severe courses of infection with food-borne pathogens have been reported (5-8), there is very little data concerning the epidemiology of these infections in the transplant population as a whole. In a series of 52 patients from 2007, Arslan et al. reported that of 33 episodes of infectious diarrhea in SOT recipients, almost half showed presence of food-borne pathogens in stool samples (9). At the same time, a large-scale prospective study of 942 SOT recipients by Cervera et al. from 2011 reported no severe infectious episodes of food-borne origin (10). These two results could suggest

that the vast majority of SOT recipients presenting with food-borne infection have benign courses and that severe courses remain rare, as in the general population.

In addition, the rate of observance of the recommendations in this population has very rarely been studied. A 2011 paper showed that a high proportion of SOT recipients reported consumption of unsafe foods since the time of the transplant, as well as insufficient knowledge of food safety recommendations, albeit with a modest number of participants (11). A 2015 study of lung transplant recipients reported a majority avoided consumption of risk-associated foods (RAFs), albeit without differentiating between those who never consumed them at all and those who did so occasionally (12).

The aim of this study was to evaluate the level to which food-safety recommendations are followed in a population of SOT recipients who are regularly seen at a university hospital center in Switzerland. We used a self-report questionnaire sent to participants by post. We assessed in a detailed manner the adherence or not or of SOT recipients to recommendations about food safety. Since there are little or no data on this aspect of life after transplantation, caregivers often find themselves in a difficult position when trying to inform patients with regard to safety-related questions. Since severe food-borne infections seem to remain a rare occurrence in transplant recipients (3, 5, 6), it could be hypothesized that it is because they scrupulously follow all given recommendations. This study aimed to provide some answers to this question. Possible clinical implications may be adjustment of recommendations and advice to at-risk groups if applicable.

Materials and methods

Selection of participants

For this study, we screened all patients having received kidney, liver, lung or heart transplants between January 2012 and June 2017, followed at our institution and at least 18 years old. Exclusion criteria were the inability to correctly understand the questionnaire due to cognitive disorders such as dementia, psychiatric disorders, or insufficient knowledge of French.

Study design

We designed a study questionnaire based on those used in a previous report on patients living with HIV (who are required to follow similar guidelines to those suggested to transplant recipients) and in a small-scale study of SOT recipients (11). The questionnaire covered five main areas. First, participants were asked to describe their age, their sex and their level of education. Secondly, they were questioned on their consumption of risk-associated foods (RAFs) since the transplant. RAFs included in the study were foods presenting high risks of colonization by pathogens, notably undercooked meat, raw fish and seafood, raw beansprouts and non-pasteurized milk and egg products. Scoring of frequency of consumption was based on a Likert scale

with 0 being “never”, 1 being “rarely”, 2 being “occasionally”, 3 being “often” and 4 being “very often”. Thirdly, participants were asked to score their adherence to hygiene and food-handling practice recommendations. These included visually checking cooked meat for correct cooking levels, hand hygiene, separation of cooked and uncooked foods in the fridge, and the use of clean utensils for handling cooked and uncooked foods. These aspects were also scored on a Likert scale with 0 being “never”, 1 being “rarely”, 2 being “occasionally”, 3 being “most of the time” and 4 being “all of the time”. We also asked whether participants owned independent thermometers for their fridges, and whether they checked cooking of meat using a meat thermometer but did not include these answers in the final analysis since these two recommendations are not explicitly mentioned in the AST guidelines. The fourth area of the questionnaire covered participants’ perception of risk associated with food, how they felt they had been informed about the issue, and if they had sought information themselves. We asked whether they thought food-associated behavior was important to reduce the risk of infection and whether they felt their own behavior(s) contributed to protect them against foodborne infections. These questions were scored from 0 (“Completely disagree”) to 4 (“Completely agree”) with 2 being “Do not know”. We also asked how participants evaluated their absolute risk of infection on a scale from 0 (“Non-existent”) to 4 (“Very high”) with 2 being “Medium”. Finally, we asked whether participants felt they had been informed about foods to avoid and hygiene recommendations around the time of the transplant and whether they themselves had sought out more information about these issues since the transplant. These questions were scored from 0 (“No”) to 4 (“Yes”) with 2 being “Do not know”. Finally, we included a section with seven hypothetical situations where participants were expected to identify where a risk was present and choose between two possible courses of action. One was considered to be correct and the other one wrong. An answer of “I don’t know” was scored as incorrect since we deemed it to show the participant would not know how to act in a potentially dangerous situation. We also included the possibility to answer “I would never be put in this situation” to account for participants following a vegetarian diet for example.

The primary outcome of the study was adherence to AST recommendations. These use the wording “avoid” to indicate foods that should not be ingested. We considered the wording vague and decided that positive adherence to guidelines was defined as *never* consuming such food. For hygiene recommendations, we decided that to account for occasional forgetting of hand hygiene for example, adherence to recommendations was defined as following them *all of the time* or *most of the time*.

To reduce confirmation bias, with potential misreporting of food safety behaviors in a study dealing with that subject exclusively, we informed participants that the study intended to cover all aspects of food behavior, including the consumption of sugary, fatty or salty foods. Accordingly, the survey contained questions covering all these areas. The answers to the questions unrelated to food safety were not scored or analyzed in the study.

We decided to send prospective participants study information documents by post. It has been shown that postal surveys can expect a higher response rate than e-mail surveys (13). The study package included an introductory letter, a 10-page document

explaining the study in detail, the anonymous questionnaire bearing their unique identifier, an informed consent form, and a postage-paid return envelope with which to send back the documents. The detailed information contained contact details for the investigators, instructions on how to participate and how to refuse to participate. Informed consent was considered to have been obtained either with the completed questionnaire or the consent form filled out.

Questionnaires were sent out initially on November 14th, 2017, and a second identical study package was sent to patients from which no response had been obtained approximately three months later. Missing or incomplete consent forms were made available to patients during their periodic visits to give them the opportunity to fill them out correctly. We also sent some patients new forms to fill out at home if next visits were not planned or too far in the future.

Questionnaires were filled out with the data coded by a unique identifier linking the questionnaire to a specific participant. Only essential investigators in the study had access to the patient database which was only consulted for necessary purposes.

Approval for the project was obtained from the Ethics Committee of the Canton of Vaud, Switzerland (project n° 2017-01625).

Statistical analysis

Completed questionnaires were entered into an electronic database. Statistical analysis was performed with STATA software (*StataCorp. 2017. Stata Statistical Software: Release 15. College Station, TX: StataCorp LLC*) for analysis. No participant having returned a completed survey was excluded from the study.

Some participants failed to fill out the questionnaire in a complete fashion and had left some questions unanswered. Such missing data was always reported as such and was then excluded from some of the analyses.

Given the ordinal nature of most of the data, we used the Wilcoxon or Kruskal-Wallis rank-sum tests to identify differing distributions to a significance level of $\alpha = 0.05$ unless otherwise specified. For analyses including age data, we used standardized least-squares linear regression, as specified in the appropriate figures.

Results

Baseline characteristics of study population

A total of 515 patients having undergone organ transplantation in the period from 1st of January 2012 to 30th June 2017 were screened. 205 patients either did not meet inclusion criteria (deceased, under 18 years of age, transplant follow-up elsewhere than the CHUV) or met exclusion criteria (subjective evaluation by physicians meeting them regularly) and were excluded. The remaining 310 patients were included in the study and received study packages as mentioned above. 197 patients returned a

completed questionnaire, 81 did not reply, 27 replied but declined to participate and one patient had died. 4 packages were returned as wrongly addressed. The 197 questionnaires filled out were included in the analysis (Fig. 1).

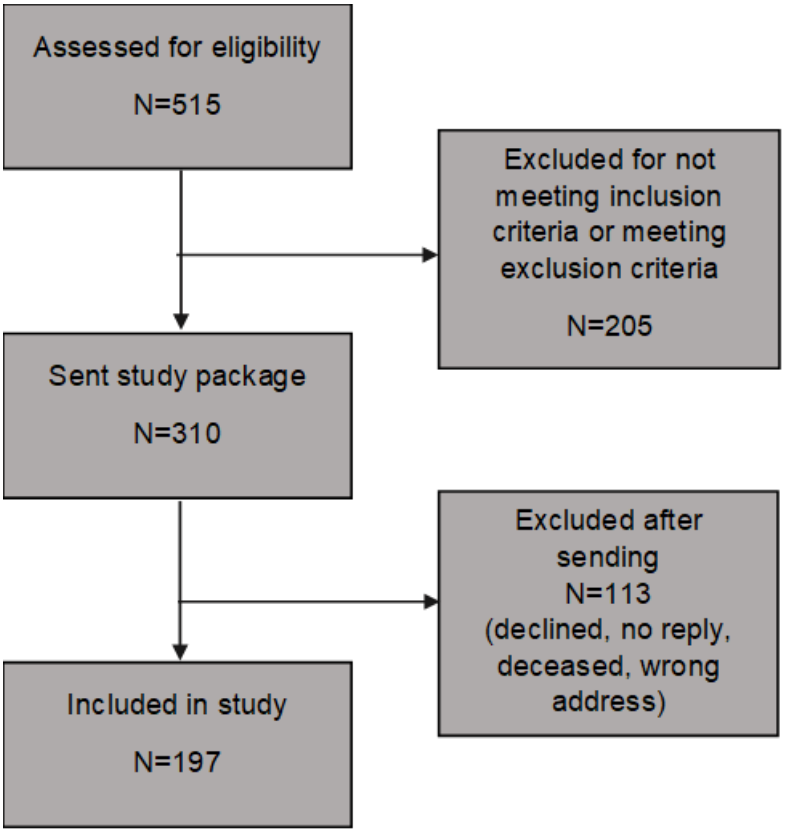

Figure 1: study flow chart

Of the 197 participants, 123 (62%) were men. The population included a majority of middle-aged patients, with 112 (57%) being between 45 and 65 years old. Less than 10% were either less than 30 years old or above 75 years old. 151 (77%) had completed either elementary school or an apprenticeship and 44 (22%) had further education in the form of a high-school or university degree. 2 (1%) did not report their educational history.

Sixteen (8%) participants had received a heart transplant, 29 (15%) a liver, 35 (18%) lungs and 117 (59%) a kidney. The proportions of heart and kidney patients were close to those reported by the STCS population in its 2017 activity report (7% and 56% respectively), whereas the proportions of lung and liver patients were lower in the STCS population (10% and 20% respectively) (14). This may partly be due to the fact that the CHUV is a center specializing in lung transplants in particular.

The time since transplantation was evenly distributed across the sample, with 32 (16%) patients having less than one year's follow-up, 44 (22%) between one and two years, 38 (19%) between two and three, 34 (17%) between three and four, 36 (18%) between four and five and 13 (6%) more than five years. It is of interest to note that this gives

32 (16%) patients within the first year of follow-up where immunosuppression is at the highest level.

Sex n (%)	**n = 197**
Female	74 (37.56)
Male	123 (62.44)
Age (years)	
Median	58
Range	19 - 79
Received organ n (%)	
Heart	16 (8.12)
Liver	29 (14.72)
Lung	35 (17.77)
Kidney	117 (59.39)
Time since transplant (years)	
Median	2.67
Range	0.39 - 5.81
Education level n (%)	
Elementary school	37 (18.78)
Apprenticeship	114 (57.87)
High school	21 (10.66)
University	23 (11.68)
Not reported	2 (1.02)

Table 1: baseline characteristics of study population

Adherence to AST recommendations on food avoidance

The frequencies at which study participants had consumed each RAF are summarized in Table 2, where n=197. We found that 143 participants (73%) had consumed potentially unsafe meat products on at least one occasion, 58 (29%) had consumed raw fish, 43 (22%) had consumed raw soybeans, 125 (63%) had consumed unpasteurized egg products and 137 (70%) had consumed unpasteurized milk products. Swiss cultural norms are reflected in these data, with popular products such as raw charcuterie and unpasteurized milk and egg products being among the most popular items with our study population.

		Never	Rarely	Occasionally	Often	Very often
Meat products n (%)	**Undercooked red meat** missing : 12 (6.09)	86 (43.65)	42 (21.32)	36 (18.27)	19 (9.64)	2 (1.02)
	Undercooked poultry missing : 6 (3.05)	158 (80.2)	22 (11.17)	9 (4.57)	2 (1.02)	0 (0)
	Raw charcuterie missing 5 (2.54)	64 (32.49)	57 (28.93)	52 (26.4)	16 (8.12)	3 (1.52)
	Steak tartar missing 12 (6.09)	137 (69.54)	25 (12.69)	17 (8.63)	6 (3.05)	0 (0)
Seafood n (%)	**Sushi** missing 4 (2.03)	154 (78.17)	23 (11.68)	12 (6.09)	2 (1.02)	2 (1.02)
	Ceviche missing 22 (11.17)	161 (81.73)	5 (2.54)	7 (3.55)	2 (1.02)	0 (0)
	Oysters missing 4 (2.03)	157 (79.7)	23 (11.68)	11 (5.58)	1 (0.51)	1 (0.51)
Eggs n (%)	**Undercooked eggs** missing 5 (2.54)	117 (59.39)	46 (23.35)	22 (11.17)	6 (3.05)	1 (0.51)
	Raw eggs missing 5 (2.54)	89 (45.18)	57 (28.93)	37 (18.78)	6 (3.05)	3 (1.52)
Beansprouts n (%)	**Raw soybean sprouts** missing 4 (2.03)	150 (76.14)	31 (15.74)	9 (4.57)	3 (1.52)	0 (0)
Dairy products n (%)	**Raw milk** missing 6 (3.05)	167 (84.77)	16 (8.12)	4 (2.03)	3 (1.52)	1 (0.51)
	Unpasteurized cheese missing 4 (2.03)	55 (27.92)	48 (24.37)	54 (27.41)	27 (13.71)	9 (4.57)

Table 2 : frequency of consumption of RAFs as reported by study participants. N=197.

In further analysis, we included only participants who had answered all questions in this section of the survey, leaving n=154. Only 11 participants (7%) reported never consuming any RAFs since the time of transplantation, and 143 (93%) reported consumption of at least one RAF on at least one occasion. We asked how many different kinds of RAFs each participant had consumed on at least one occasion since time of the transplant, i.e. how many RAFs each participant had scored “rarely” or higher in the survey. We found that the 154 analyzed participants consumed a median of 4 (IQR 2-6) different kinds of RAFs (Fig. 2a). Next, we determined the maximum frequency of consumption of any RAF for each participant (the RAF consumed at the highest frequency was considered for each participant) and calculated the median frequency of RAF consumption in the study population. We determined that the median consumption of RAFs was “occasionally” (IQR consumption ranged from “rarely” to “often”) (Fig. 2b).

Subsequently, we analyzed whether consumption of a higher number of different RAFs or consumption of any RAF at higher frequency were associated with any of the baseline characteristics of the study population, including sex, age, organ (in particular lung transplant recipients), time after transplantation and education level. We found that a longer time since transplant was significantly associated with consumption of a higher number of different RAFs, which is not surprising since there has been more time available to consume RAFs ($p < 0.05$, Fig. 2c). However, time after transplantation was also associated with higher frequency of consumption of any RAF ($p < 0.05$, Fig. 2d). The male sex was associated with consumption of a higher numbers of RAFs ($p < 0.05$, Fig 2e) but not with higher frequency of consumption ($p = 0.0543$, Wilcoxon rank-sum test, Fig. 2f). There were no differences between recipients of different organs, or according to age or educational level (p NS, Wilcoxon rank-sum test, Kruskal-Wallis rank sum test or standardized least squares regression, data not shown).

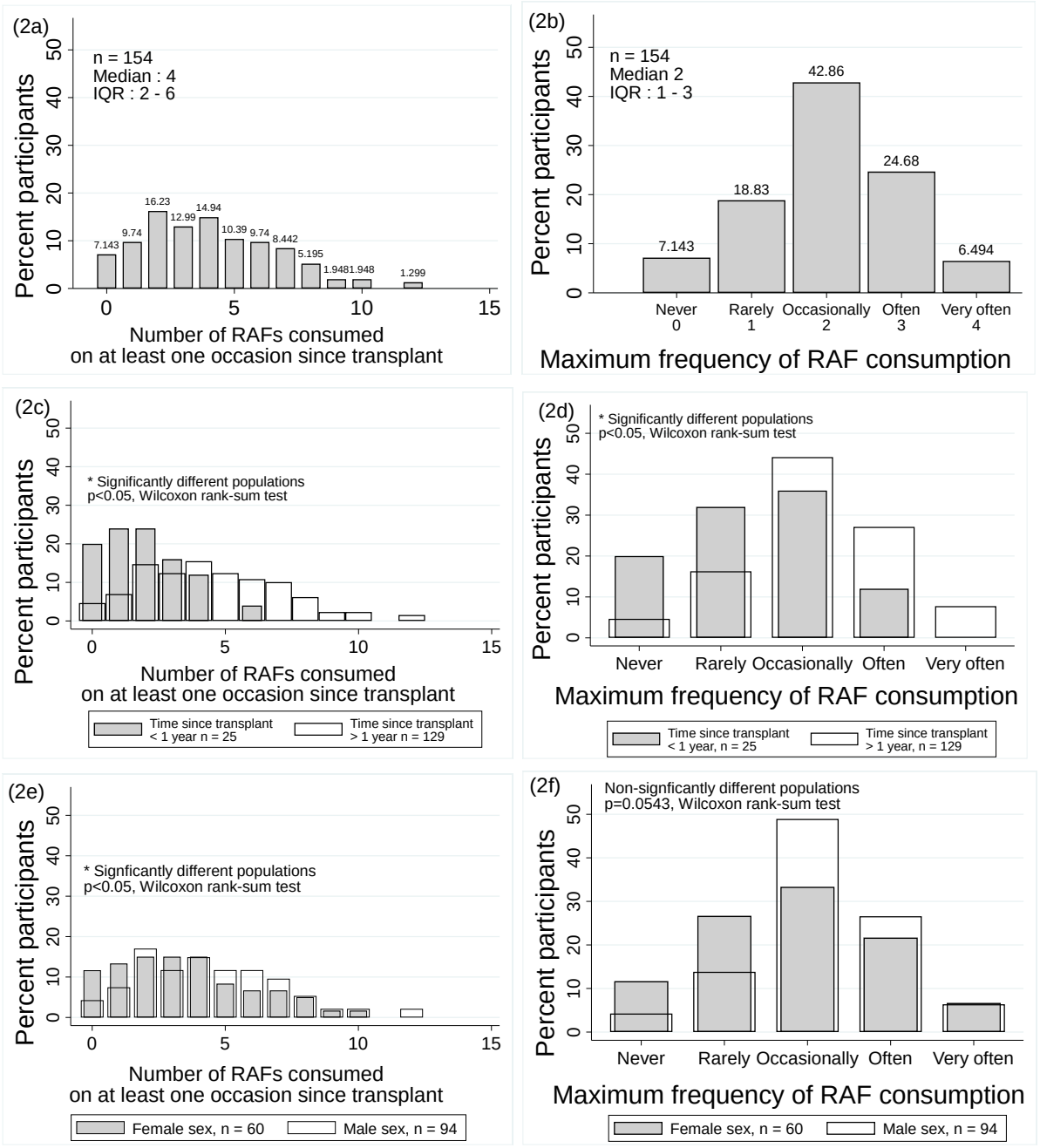

Figure 2 : histograms of number of different RAFs consumed on at least one occasion (i.e. number of RAFs scored as "rarely" or more) in the total study population (a) and according to time since transplant (c), and sex (e). Frequency of consumption of any RAF in total study population (b) and according to time since transplant (d) and sex (f). Bar heights are proportion of participants in percent. N = 154.

Taken together, our data show that 74% of our study participants consume at least one RAF at least occasionally and that 54% of the participants had consumed four or more RAFs at least once since the transplant took place. Consumption of any RAF was excluded for only 7% of participants. Being in the first year since transplant is associated with lower consumption of RAFs, as is the female sex.

Adherence to AST hygiene and food-handling recommendations

The second part of the survey was dedicated to evaluating adherence to food-handling and hygiene rules. We questioned participants on four basic hygiene rules, namely hand washing, separation of raw and cooked food in the cold storage spaces, visually checking cooking status of meat, and usage of different or clean utensils for handling raw and cooked foods. 100 (51%) always washed their hands before handling food, 103 (52%) always checked meat cooking visually, 106 (54%) always used clean or different utensils for cooked and raw foods and 120 (61%) always separated cooked food from raw in the refrigerator (Tab. 3).

	Never	Rarely	Occasionally	Most of the time	Always
Checking meat cooking visually n (%) missing 10 (5.08)	3 (1.52)	7 (3.55)	4 (2.03)	70 (35.53)	103 (52.28)
Hand washing n (%) missing 2 (1.02)	4 (2.03)	1 (0.51)	12 (6.09)	78 (39.59)	100 (50.76)
Separation of cooked and uncooked foods in refrigerator n (%) missing 3 (1.52)	7 (3.55)	5 (2.54)	5 (2.54)	57 (28.93)	120 (60.91)
Using different or clean utensils for cooked and uncooked foods n (%) missing 4 (2.03)	18 (9.14)	9 (4.57)	16 (8.12)	44 (22.34)	106 (53.81)

Table 3: frequency of adherence to hygiene recommendations by 197 study participants.

In accordance with our definition of following recommendations, we analyzed how many rules each participant followed *all the time* or *most of the time*. We excluded from this analysis 12 participants who had not answered all hygiene-related questions, giving n=185. We found that 70% of the participants followed all four rules all or most of the time (Fig 3a). We also analyzed in a more stringent manner, asking how many rules each participant followed all the time exclusively. This showed that only 48 (26%) followed all rules all the time. However, as explained in the introduction, we considered this to be an excessively conservative manner of interpreting data, since occasionally forgetting to wash one's hands for example can happen, without necessarily meaning that the person does not apply recommendations.

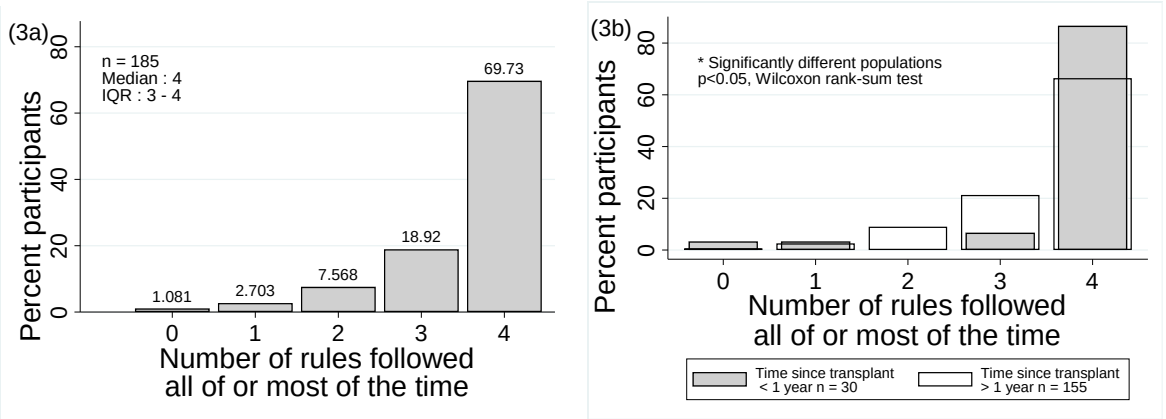

Figure 3 : (a) histogram of number of hygiene recommendations adhered to all the time or most of the time by study participants. Bar labels are percent participants. (b) histogram of number of hygiene rules followed all the time or most of the time according to time after transplant. Bar heights are percent participants. N = 185

As before, we asked whether these results could be associated with any of the baseline characteristics of the study population. In line with the previous findings, we observed that participants less than one year after transplant follow more rules all or most of the time compared to participants beyond one year after transplantation ($p < 0.05$, Wilcoxon rank-sum test, Fig. 3b). There were no other differences in the number of rules respected all or most of the time according to sex, age, transplanted organ or educational level (p NS, Wilcoxon rank-sum test, Kruskal-Wallis rank sum test or standardized least squares regression, data not shown).

It is to be noted that we also asked participants whether they owned an independent fridge thermometer and whether they checked meat cooking temperatures with a meat thermometer. 139 (71%) did not own an independent thermometer, 47 (24%) did, 3 (2%) did not know and 8 (4%) did not answer the question. 6 (3%) always checked meat cooking with a thermometer whereas 148 (75%) never did. We did not include these questions in the final analysis because they are not specifically mentioned in the AST recommendations or in the recommendations given in our study center. However, they are regularly included in general population food safety recommendations (2). One can argue that the only way to conclusively establish that meat is cooked correctly is to measure its temperature and thus that SOT recipients should apply this rule as well.

Taken together, our data show that while only 25% of participants follow all tested hygiene rules all the time, almost 70% follow all rules at least most of the time. Participants in the first year since transplant tend to follow more rules than participants more than one year after transplant.

Total score including RAF and hygiene results

To obtain a global image of which percentage of recommendations were followed by each participant, we created a score where one point was given for each RAF that was *never* consumed and each hygiene recommendation that was followed *always* or *most of the time*. This gave a score between one and 16. We excluded participants who had not answered all questions in these areas, giving n = 149 for this analysis. The median score was 12 (IQR 10-14) (Fig. 4a).

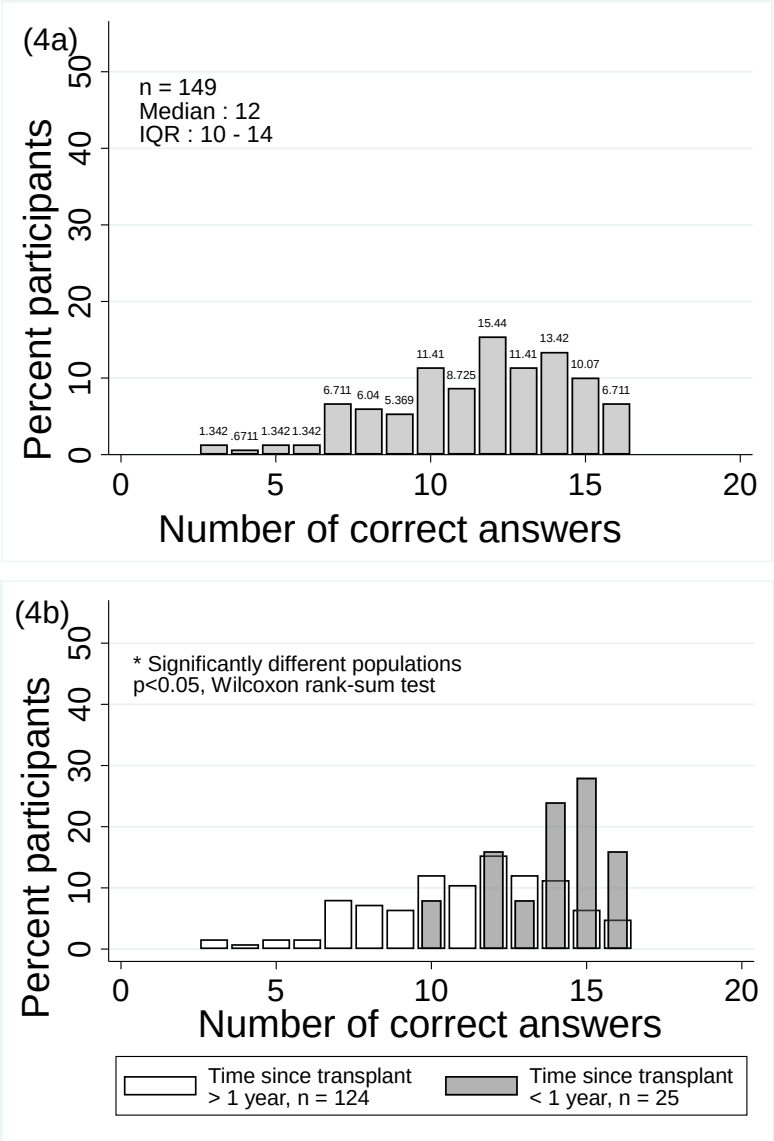

Figure 4: histograms of number of correct answers given by study population. Correct answers are "never" for RAF recommendations and "most of the time" or "All the time" for hygiene recommendations. Maximum score possible is 16. (a) histogram of number of correct answers given by study population. Bar labels represent proportion of participants in percent. (b) number of correct answers given by population according to time since transplant. Bar heights represent proportion of participants in percent. N = 149.

As with other analyses, we asked whether higher or lower scores were associated with any factors in population. Again, we found that participants in the first year since transplant tended to have answered more questions correctly ($p<0.05$, Wilcoxon rank sum test, Fig. 4b). There were no other associations with baseline characteristics.

This analysis shows our study population of SOT transplant recipients adhere to a median of 12 out of 16 tested recommendations in RAF and hygiene behavior. Participants less than one year post transplant follow more recommendations than those with longer follow-up.

Risk perception and information

Our survey also aimed to evaluate patients' perception of infection risk, particularly food-borne infection, on a basic level, as well as to explore the information given by transplant teams and sought by themselves since transplantation. Data from these seven questions are reported in Tab. 4.

	Total disagreement	Mostly disagree	Does not know	Mostly agree	Total agreement
Food behavior is important to reduce risk of infection n (%) missing 3 (1.52)	2 (1.02)	7 (3.55)	13 (6.6)	65 (32.99)	107 (54.31)
My food behavior contributes to reducing my personal risk of infection n (%) missing 3 (1.52)	1 (0.51)	7 (3.55)	20 (10.15)	85 (43.15)	81 (41.12)
Was given information about foods to avoid around time of transplant n (%) missing 4 (2.03)	11 (5.58)	8 (4.06)	14 (7.11)	40 (20.3)	120 (60.91)
Sought out information about food to avoid n (%) missing 4 (2.03)	26 (13.2)	24 (12.18)	12 (6.09)	46 (23.35)	85 (43.15)
Was given information about hygiene recommendations n (%) missing 4 (2.03)	9 (4.57)	7 (3.55)	6 (3.05)	37 (18.78)	134 (68.02)
Sought out information about hygiene recommendations n (%) missing 4 (2.03)	23 (11.68)	27 (13.71)	7 (3.55)	43 (21.83)	93 (47.21)
	Non-existent	**Low**	**Medium**	**High**	**Very high**
Self-assessment of risk of infection n (%) missing 7 (3.55)	4 (2.03)	69 (35.03)	74 (37.56)	36 (18.27)	7 (3.55)

Table 4 : table of frequencies for answers to information and risk assessment questions. N = 197

Overall, 172 participants (87%) felt that food behaviors were important for reducing the risk of infection and 166 (84%) found that their own habits contributed to reducing their personal risk. In the matter of personal risk evaluation, 4 participants (2%) felt their risk was non-existent, 69 (35%) felt it was low, 74 (38%) classed it as medium, 36 (18%) felt it was high and 7 (4%) feared it was very high.

In the question of information, 160 participants (81%) felt they had been informed about avoiding RAFs around the time of the transplant, whereas 19 (10%) felt they had not. 131 (67%) had sought out information themselves since that time and 50 (25%) had not. 171 (87%) felt they had been informed about hygiene and 15 (8%) had not. 136 (69%) had sought out information about this issue themselves and 50 (25%) had not.

Knowledge testing by hypothetical risk-associated situations

The final part of the survey aimed to investigate risk-assessment capabilities of the participants by confronting them with a number of hypothetical situations applying the recommendations of the AST (2, 11). We thought of situations that may arise commonly in everyday life, either with food preparation and/or consumption in the home, at the restaurant or when eating at a friend's home. The choice between two actions was left to the participants, one of which was considered to be correct and the other incorrect. Participants were also given the opportunity to answer "Don't know". This was scored as incorrect, since it reflects a lack of knowledge and the participant would not know how to act when confronted with that situation. They could also answer that they would never be put in that particular situation, in order to accommodate participants who, for example, were vegetarian in a question about meat consumption, or who never ate in restaurants in a question about eating out. Data from these questions are presented in Tab. 5.

The first situation covered the topic of contamination of salad by raw poultry. The correct answer was that the salad should not be consumed. This question was answered correctly by 38 (19%) of participants and wrongly by 82 (42%). 75 (38%) said they would never encounter such a choice.

The second addressed the issue of washing utensils properly after contact with raw poultry. The correct answer was that washing should be done with detergent and hot water. Here, 100 (51%) answered correctly and 56 (28%) would be never be put in that situation. 36 (18%) felt that rinsing with hot water was sufficient to ensure safety.

Thirdly, we asked about the proper washing of fruits before consumption. The correct answer was that fruit needed to be washed carefully. Here 182 (92%) answered correctly and 10 (5%) were not put in that situation.

The fourth situation assessed knowledge about the recommendation that left-over food need be heated to a sufficient temperature before eating. 71 (36%) answered correctly and 46 (23%) felt the situation not-applicable to them. 76 (39%) answered incorrectly.

We explored behavior to adopt in restaurants in the fifth situation. Participants were asked about the appropriate response to being brought undercooked red meat. The correct attitude would be to ask for the meat to be cooked for longer. 120 (61%) would adopt this attitude, and 33 (17%) would not be faced with the choice. 40 (20%) felt this was not necessary.

Finally, we confronted participants with the scenario in which a dish made with raw eggs was to be served at a friend's home. 100 (51%) would not feel safe consuming it and 37 (19%) would not be faced with that choice. 56 (28%) did not see a problem with eating the dish that was served.

	Wrong	Correct	Situation not applicable
Situation 1: contaminated food n (%) missing 2 (1.02)	82 (41.62)	38 (19.29)	75 (38.07)
Situation 2: correct washing of utensils n (%) missing 5 (2.54)	36 (18.27)	100 (50.76)	56 (28.43)
Situation 3: washing of fruit n (%) missing 2 (1.02)	3 (1.52)	182 (92.39)	10 (5.08)
Situation 4: heating of left-over food n (%) missing 4 (2.03)	76 (38.58)	71 (36.04)	46 (23.35)
Situation 5: dealing with undercooked food in restaurant n (%) missing 4 (2.03)	40 (20.3)	120 (60.91)	33 (16.75)
Situation 6: raw eggs at a friends house n (%) missing 4 (2.03)	56 (28.43)	100 (50.76)	37 (18.78)

Table 5: answer frequencies for situational questions. N = 197

For the participants who answered each question, we generated a score where a point was given for each incorrectly answered question (N=187). The median overall score was one (IQR 0-2) (Fig. 5a). The score showed that around 50% of participants had addressed zero or one situation incorrectly, and the other 50% had addressed more than one situation incorrectly.

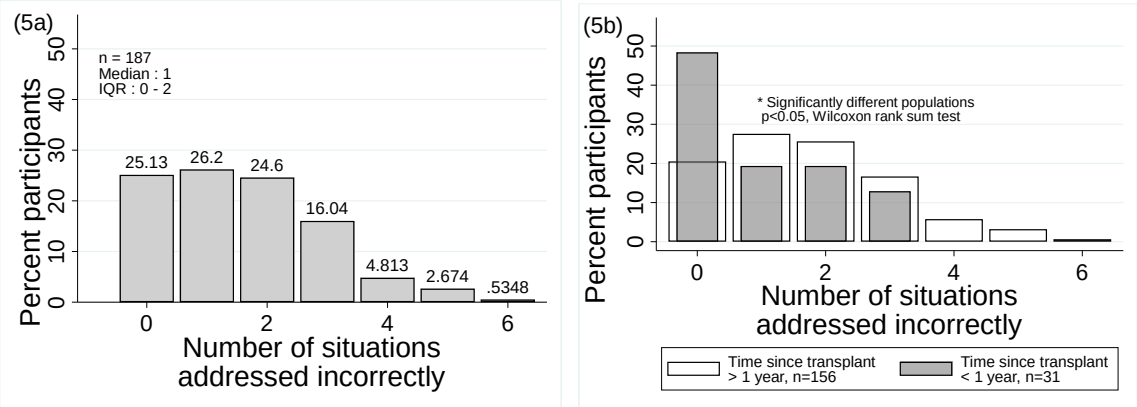

Figure 5: histograms of number of hypothetical situations addressed incorrectly by study participants. (a) Number of situations addressed incorrectly across study population. Bar labels are percent participants. (b) Number of situations addressed incorrectly according to time since transplant. Bar heights represent proportion of participants in percent. N = 187.

We analyzed whether correctly addressing more situations was associated with any of the characteristics, as in the previous analyses. We found a significant association with time since transplant (Fig. 5b). There was no association with other baseline characteristics (p NS, Wilcoxon rank-sum test, Kruskal-Wallis rank sum test or standardized least squares regression, data not shown).

Finally, we asked whether addressing situations in an incorrect manner was associated with a lower number of correct answers in the general score we established earlier. This was the case when evaluated using a Chi-squared test (Pearson's Chi-squared 106.0042 with 60 d.f., $p < 0.001$). This indicates that knowledge of which situations are

associated with a risk of infection is linked to concrete behavioral changes leading to less risk-taking.

Discussion and conclusion

In this descriptive study, we aimed to describe detailed food behaviors in a population of patients having received a solid-organ transplant. To this end we used a traditional mail-sent self-report survey and included 197 patients having received a heart, lung, liver or kidney transplant over a 5-year period. In the survey we asked about frequency of consumption of a number of risk-associated foods (RAFs), frequency of adherence to hygiene and food-handling recommendations and how participants addressed hypothetical situations where they were asked to apply theoretical knowledge of recommendations tested in the previous questions. We also evaluated their level of information on food safety and their self-assessment of personal risk of infection. We attempted to find associations between characteristics such as age, sex, received organ, educational level and time since transplant, and answers to survey questions.

We found that a majority of transplant recipients report at least occasional consumption of a number of RAFs, with only a very small minority able to reliably report never having consumed a single RAF since the transplant. Study participants in the first year of follow-up consumed fewer different kinds of RAFs (which is to be expected since more time has passed for participants with longer times since transplant to allow for consumption of RAFs) at a lower frequency than patients with a longer duration of follow-up. Women also tended to consume a lower number of RAFs with a at a lower frequency, however this was not statistically significant.

In the matter of hygiene and food-handling recommendations we found that most participants did not follow rules all the time. Indeed, only about half of the participants reported washing their hands all the time before handling food, a recommendation not only for transplant patients but also for the general population. However, when analyzing how many rules were followed all or most of the time, we found that 70% of participants followed all rules at least most of the time. Again, there was an association between time since transplant and better observance of rules.

When associating results from the food consumption and food-handling parts of the survey, we found again that patients in the first year of follow-up were more likely to answers questions “correctly” i.e. never to have consumed a given RAF and always or most of the time follow a hygiene rule.

In the survey, we also described participants’ perception of risk of infection associated with food and of information received. We found that the vast majority of participants felt they had been informed about food eviction and hygiene recommendations, with a large portion also seeking out information themselves about these issues. Risk of infection was described as low or medium by most participants.

Finally, we showed that most participants did not identify all risk-associated situations correctly and chose either the wrong course of action or did not know which one would be the correct one to take. Again, being in the first year since transplant was associated with a higher number of correctly handled situations.

Taken together, our data suggest that transplant recipients treated at our institution (CHUV) do not scrupulously follow recommendations on food safety, in particular those related to consumption of RAFs. There is better observance of rules pertaining to hygiene and food handling. Overall, being in the first year after transplant surgery were significantly associated with less risk-taking behavior. Further studies will be needed to further characterize the extent to which transplant patients take risks on a more objective basis. This could be achieved as has been done in other food safety studies by using face-to-face interviews and food diaries to more accurately report behavioral patterns. This would also allow investigators to reduce missing data.

Our results are comparable to the few other studies of food safety in SOT recipients or HIV patients. Indeed, Kosa et al. report the vast majority of SOT recipients consuming RAFs after transplantation, but with relatively high adherence to hygiene recommendations (11). Jain et al. show that most lung transplant recipients avoid consumption of a selection of RAFs, but in the text is was difficult to assess whether their patients actually consume them or not (12). It is important to note that on average, lung transplant patients have higher levels of immunosuppression than other organ recipients, which may be part of the reason the Jain study shows higher levels of avoidance than ours. However, our data does not show more avoidance in lung transplant patients. Dworkin et al. report an average score of correct answers of 63% in their AIDS patients, compared to the average of 72% (11.55/16) which we present here (15).

Our study presents a few strong points. Firstly, we asked about concrete consumption of RAFs rather than about eviction, which participants may have scored differently. Secondly, we confirmed that the hypothetical situations studies were a way of evaluating whether theoretical knowledge was associated with action items, which it seemed to be. Thirdly, we were able to identify the time post transplant as being a factor associated with, among others, increased consumption of RAFs. This is probably at least partly due to caregivers in our institution informing patients that immunosuppression is at its highest point in the first year post-transplant and that special care must be taken to minimize risk of infection. Our data is the reflection of patients' participation in this effort. It may show that a refresh of food safety recommendations may be useful at this point of follow-up to ensure optimal protection also after one year. Finally, we were able to recruit a relatively large sample, which seemed to be representative of the transplant recipients population.

Despite relatively clear-cut results in our primary outcomes, our study has a number of weaknesses. Firstly, self-report surveys are often less reliable in general than objective data. Secondly, our survey was not a standard validated survey since it is not a subject that has been often studied in the past. Thirdly, questions were sometimes left somewhat vague. For example "raw charcuterie" may not have the same meaning for two different participants depending on their knowledge of various products. However, despite the weaknesses of our study, we have been able to show that a large proportion of transplant patients do not completely adhere to recommendations.

Interpreting our data from the point of view of safety and risk is difficult. As mentioned in the introduction of this study, recommendations are not evidence-based but are

rather the result of a mixture of observations, expert opinion and common sense. Indeed, it would seem reasonable to avoid eating food that has been shown to occasionally contain virulent pathogens if one is immunocompromised. However, it is unknown if regular consumption of a number of RAFs, as we have reported in our study participants, is associated with an increased risk of infection, hospitalization or mortality. Similarly, it is also not known whether consuming one RAF “very often” is more or less “dangerous” than consuming five different RAFs “occasionally”. Answering such a complex question in a completely satisfactory manner would require a comprehensive long-duration prospective study of a large cohort of patients who regularly report on their food behaviors, to establish whether patients consuming more RAFs more often have a higher risk of morbidity and mortality. Such a study would be important in to address important questions which patients often have in relation to food safety. For the moment it is difficult to answer questions such as “can I eat this dish occasionally and still be safe?” because the data to provide that information does not yet exist. In all probability, it would in any case not be a clear-cut “yes” or “no” but rather a discussion of relative risks which a comprehensive study would perhaps be able to provide. In a more immediate future, we aim to complete our data with further study of our cohort. Indeed, despite the relative rarity of severe food-borne infections, analysis of microbiology results from our participants since their surgery may show higher frequency of positive findings for food-borne pathogens in patients with less strict food safety behaviors.

In conclusion, we show that 93% of transplant recipients report consuming RAFs since transplant. 70% of recipients follow hygiene recommendations all the time or most of the time. Being in the first year since transplant is associated with better observance of food avoidance and hygiene recommendations. Whether these results have an implication for epidemiology of food-borne infections remains to be investigated.

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Habitudes alimentaires après transplantation d'organes : enquête sur le comportement des patients Lausannois

Médecin responsable : Dr Oriol MANUEL, CHUV

Questionnaire pour les patients

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1. Données générales

Veuillez indiquer les informations suivantes :

1.1 Âge : …….

1.2 Sexe : homme femme (entourer ce qui convient)

2. Niveau d'éducation

2.1 Veuillez cocher la réponse qui convient (une seule réponse).

École obligatoire	O
Apprentissage, formation professionnelle	O
Gymnase	O
Diplôme universitaire	O

3. Histoire depuis votre greffe

3.1 Veuillez cocher la ou les réponses qui conviennent.

Depuis votre greffe (ou depuis la première si vous en avez subi plus d'une), avez-vous été victime d'une infection sévère ?	O
Si oui, est-ce qu'elle a nécessité une hospitalisation ?	O
Dans l'année qui vient de s'écouler, avez-vous été victime d'un épisode de rejet aigu ?	O

4. Questions sur les habitudes alimentaires

4.1 Pour chaque question, veuillez cocher la réponse qui convient (une seule réponse).

Depuis votre greffe combien de fois avez-vous consommé :	Jamais	Rarement	Occasionnellement	Souvent	Très souvent
De la viande rouge saignante ?	O	O	O	O	O
De la viande rouge cuite à point ?	O	O	O	O	O
Des spaghetti bolognaise ?	O	O	O	O	O
De la viande rouge bien cuite ?	O	O	O	O	O
De la volaille restée rosée après la cuisson ?	O	O	O	O	O

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Depuis votre greffe combien de fois avez-vous consommé :	Jamais	Rarement	Occasionnellement	Souvent	Très souvent
Des bonbons ?	O	O	O	O	O
De la volaille complètement blanche après cuisson ?	O	O	O	O	O
Un steak tartare ?	O	O	O	O	O
Des œufs brouillés restés légèrement liquides ?	O	O	O	O	O
Du chocolat ?	O	O	O	O	O
Des pousses de soja crues ?	O	O	O	O	O
Des sushis ?	O	O	O	O	O
Des haricots en conserve ?	O	O	O	O	O
Du ceviche ?	O	O	O	O	O
Des carottes crues ?	O	O	O	O	O
Des carottes cuites ?	O	O	O	O	O
Des coquillages crus (huîtres…) ?	O	O	O	O	O
Du lait frais non pasteurisé ?	O	O	O	O	O
Des produits à base d'œuf cru (tiramisu, mayonnaise maison…) ?	O	O	O	O	O
De la charcuterie crue ?	O	O	O	O	O
De la charcuterie cuite ?	O	O	O	O	O
Du fromage à base de lait non-pasteurisé (pâtes molles…)	O	O	O	O	O

4.2 Possédez-vous un thermomètre pour le frigo, indépendant de celui du frigo ?

Oui	Non	Je ne sais pas
O	O	O

4.3 Vous vérifiez la cuisson des viandes <u>visuellement</u> avant de les consommer ?

Jamais	Rarement	Occasionnellement	Habituellement	Toujours
O	O	O	O	O

4.4 Vous vérifiez la cuisson des viandes <u>avec un thermomètre</u> avant de les consommer ?

Jamais	Rarement	Occasionnellement	Habituellement	Toujours
O	O	O	O	O

4.5 Vous vous lavez les mains avant de manipuler des aliments que vous allez manger ?

Jamais	Rarement	Occasionnellement	Habituellement	Toujours
O	O	O	O	O

4.6 Vous séparez les viandes/poissons/fruits de mer cuits des viandes/poissons/fruits de mer crus dans votre frigo à l'aide d'emballages étanches ?

Jamais	Rarement	Occasionnellement	Habituellement	Toujours
O	O	O	O	O

4.7 Vous vérifiez la quantité de calories contenues dans les aliments que vous achetez ?

Jamais	Rarement	Occasionnellement	Habituellement	Toujours
O	O	O	O	O

4.8 Vous vérifiez que les aliments que vous achetez soient « bio » ?

Jamais	Rarement	Occasionnellement	Habituellement	Toujours
O	O	O	O	O

4.9 Vous achetez de préférence des produits de saison ?

Jamais	Rarement	Occasionnellement	Habituellement	Toujours
O	O	O	O	O

4.10 Vous utilisé une planche et un couteau différent pour couper la viande non encore cuite et la salade ?

Jamais	Rarement	Occasionnellement	Habituellement	Toujours
O	O	O	O	O

5. Questions l'importance des habitudes alimentaires

Pour chaque proposition veuillez cocher la réponse qui correspond le mieux à votre perception (une seule réponse).

5.1 Le choix des aliments est important après la greffe pour réduire le risque d'infection.

Pas du tout d'accord	Plutôt pas d'accord	Ne sait pas	Plutôt 'd'accord	Tout à fait d'accord
O	O	O	O	O

5.2 Pensez-vous que vos habitudes alimentaires contribuent à réduire le risque d'infection ?

Pas du tout d'accord	Plutôt pas d'accord	Ne sait pas	Plutôt d'accord	Tout à fait d'accord
O	O	O	O	O

5.3 Le choix des aliments est important après la greffe pour éviter la survenue de diabète.

Pas du tout d'accord	Plutôt pas d'accord	Ne sait pas	Plutôt d'accord	Tout à fait d'accord
O	O	O	O	O

5.4 Pensez-vous que vos habitudes alimentaires contribuent à réduire les risques de diabète ?

Pas du tout d'accord	Plutôt pas d'accord	Ne sait pas	Plutôt d'accord	Tout à fait d'accord
O	O	O	O	O

5.5 Le choix des aliments est important après la greffe pour réduire le risque de survenue de maladies cardiovasculaires.

Pas du d'accord	Plutôt pas d'accord	Ne sait pas	Plutôt d'accord	Tout à fait d'accord
O	O	O	O	O

5.6 Pensez-vous que vos habitudes alimentaires contribuent à réduire les risques de maladies cardiovasculaires ?

Pas du tout d'accord	Plutôt pas d'accord	Ne sait pas	Plutôt d'accord	Tout à fait d'accord
O	O	O	O	O

5.7 Le choix des aliments est important après la greffe pour réduire le risque de survenue d'épisodes de rejet aigu.

Pas du tout d'accord	Plutôt pas d'accord	Ne sait pas	Plutôt d'accord	Tout à fait d'accord
O	O	O	O	O

5.8 Pensez-vous que vos habitudes alimentaires contribuent à réduire les risques de rejet aigu ?

Pas du tout d'accord	Plutôt pas d'accord	Ne sait pas	Plutôt d'accord	Tout à fait d'accord
O	O	O	O	O

5.9 Pensez-vous que votre risque d'avoir un infarctus est ?

Nul	Faible	Moyen	Elevé	Très élevé
O	O	O	O	O

5.10 Pensez-vous que votre risque d'avoir une infection est ?

Nul	Faible	Moyen	Elevé	Très élevé
O	O	O	O	O

5.11 Pensez-vous que votre risque d'avoir le diabète est ?

Nul	Faible	Moyen	Elevé	Très élevé
O	O	O	O	O

5.12 Pensez-vous que votre risque d'avoir un rejet est ?

Nul	Faible	Moyen	Elevé	Très élevé
O	O	O	O	O

6. Questions sur l'information

Pour chacune des questions, veuillez choisir la réponse qui correspond le mieux à votre expérience (une seule réponse).

6.1 Au moment de la greffe, **vous a-t-on informé** sur l'importance d'avoir une alimentation riche en fruits et légumes ?

Pas du tout	Plutôt non	Ne sait pas	Plutôt oui	Oui
O	O	O	O	O

6.2 Depuis la greffe, **vous êtes-vous informé** sur l'importance d'avoir une alimentation riche en fruits et légumes ?

Pas du tout	Plutôt non	Ne sait pas	Plutôt oui	Oui
O	O	O	O	O

6.3 Au moment de la greffe, vous **a-t-on informé** sur l'importance d'avoir une consommation parcimonieuse en produits sucrés?

Pas du tout	Plutôt non	Ne sait pas	Plutôt oui	Oui
O	O	O	O	O

6.4 Depuis la greffe, **vous êtes-vous informé** sur l'importance d'avoir une consommation parcimonieuse en produits sucrés ?

Pas du tout	Plutôt non	Ne sait pas	Plutôt oui	Oui
O	O	O	O	O

6.5 Au moment de la greffe, **vous a-t-on informé** sur l'importance d'avoir une alimentation sans trop de produits gras ?

Pas du tout	Plutôt non	Ne sait pas	Plutôt oui	Oui
O	O	O	O	O

6.6 Depuis la greffe, **vous êtes-vous informé** sur l'importance d'avoir une alimentation sans trop de produits gras ?

Pas du tout	Plutôt non	Ne sait pas	Plutôt oui	Oui
O	O	O	O	O

6.7 Au moment de la greffe, **vous a-t-on informé** sur l'importance d'éviter certains aliments qui pourraient causer des infections ?

Pas du tout	Plutôt non	Ne sait pas	Plutôt oui	Oui
O	O	O	O	O

6.8 Depuis la greffe, **vous êtes-vous informés** sur l'importance d'éviter certains aliments qui pourraient causer des infections ?

Pas du tout	Plutôt non	Ne sait pas	Plutôt oui	Oui
O	O	O	O	O

6.9 Au moment de la greffe, **vous a-t-on informé** sur l'importance de suivre des règles d'hygiène pour éviter la contamination de la nourriture par des microbes ?

Pas du tout	Plutôt non	Ne sait pas	Plutôt oui	Oui
O	O	O	O	O

6.10 Depuis la greffe, **vous êtes-vous informés** sur l'importance de suivre des règles d'hygiène pour éviter la contamination de la nourriture par des microbes ?

Pas du tout	Plutôt non	Ne sait pas	Plutôt oui	Oui
O	O	O	O	O

7. Mises en situation

Pour chacune des situations suivantes, choisissez la réponse qui correspond le mieux à vos habitudes (une seule réponse).

7.1

Au supermarché, vous êtes au rayon yogourt. Vous hésitez entre un yogourt bio aux fruits et un yogourt nature allégé qui coûtent le même prix.

Les fruits contiennent beaucoup de sucre, donc il vaut mieux acheter le yogourt nature.	O
Le yogourt bio est naturel et donc à préférer à l'allégé malgré le sucre des fruits.	O
Je ne suis jamais confronté à cette situation	O
Ne sait pas	O

7.2

Vous préparez des blancs de poulet pour le dîner et en accompagnement vous prévoyez une salade verte. Par mégarde, quelques gouttes de jus de poulet tombent sur la salade qui repose sur le plan de travail, sans que vous ne puissiez voir quelles feuilles ont été atteintes.

Vu qu'elle sera lavée par la suite, la salade peut être consommée sans problème	O
La salade doit être jetée	O
Je ne suis jamais confronté à cette situation	O
Ne sait pas	O

7.3

Vous coupez vos blancs de poulet crus sur une planche à découper, puis vous la lavez à l'eau chaude et coupez des feuilles de salade verte dessus.

La planche à découper aurait dû être lavée avec du détergent d'abord	O
L'eau chaude suffit largement à garantir la propreté de la planche	O
Je ne suis jamais confronté à cette situation	O
Ne sait pas	O

7.4

Vous avez acheté du raisin et des pommes pour le dessert.

Vu qu'ils sont bio, ils n'ont pas besoin d'être lavés.	O
Il faut les laver soigneusement à l'eau courante avant de les manger	O
Je ne suis jamais confronté à cette situation	O
Ne sait pas	O

7.5

Le lendemain, il vous reste du poulet que vous avez conservé au frigo.

Si on est pressé, le poulet peut tout à fait être mangé froid	O
Il doit dans tous les cas être réchauffé avant d'être consommé	O
Je ne suis jamais confronté à cette situation	O
Ne sait pas	O

7.6

À l'hôtel, on vous sert un verre de jus d'agrumes. Vous expliquez au serveur que vous devez éviter le jus de pamplemousse et lui demandez si le jus en contient. Il n'en est pas sûr, mais il pense que non.

Le risque d'interaction avec les médicaments anti-rejet est faible, vous pouvez en boire un verre.	O
Dans le doute, mieux vaut éviter de consommer ce jus.	O
Je ne suis jamais confronté à cette situation	O
Ne sait pas	O

7.7

Vous vous rendez compte que vous avez oublié de cuisiner un morceau de saumon que vous avez acheté il y a une semaine. La date de péremption est maintenant dépassée de 1 jour. Quand vous ouvrez le paquet, la chair a l'air normale et l'odeur aussi.

Le poisson doit être jeté quand même	O
Il a été conservé au frigo tout le long et le paquet était scellé, le risque qu'il soit contaminé est négligeable	O
Je ne suis jamais confronté à cette situation	O
Ne sait pas	O

7.8

Au restaurant, vous avez commandé une pièce de viande de bœuf. Quand on vous la sert, vous remarquez qu'elle est restée largement rosée à l'intérieur.

Vous préférez demander à ce qu'on la recuise un peu	O
Vous aimez mieux les viandes cuites à point et au restaurant on peut faire confiance à l'hygiène	O
Je ne suis jamais confronté à cette situation	O
Ne sait pas	O

7.9

Pour faire du houmous maison, vous devez acheter des pois-chiches.

Les pois chiches en boîte sont mieux cuits et donnent donc un meilleur houmous, pour un contenu en nutriments inchangé par rapport au produit frais	O
Les pois-chiches frais contiennent plus de nutriments et sont donc à préférer par rapport aux conserves	O
Je ne suis jamais confronté à cette situation	O
Ne sait pas	O

7.10

Chez un(e) ami(e), on vous propose de partager un tiramisu frais.

Il a été fabriqué sous vos yeux avec des œufs pondus la veille, vous pouvez en manger sans risque	O
Les œufs crus sont toujours à éviter	O
Je ne suis jamais confronté à cette situation	O
Ne sait pas	O