

Framework for Solid-Organ Transplantation During COVID-19 Pandemic in Europe

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Introduction: Since the effect of the COVID-19 pandemic on solid-organ transplantation (SOT) is unclear, an online survey on the specific framework of leading European transplant centers (n=155) in 31 European countries was conducted between April 24 and May 15, 2020.

Methods: A questionnaire was designed to collect information on restrictions on SOT, protective measures, (non)governmental information policies, and individual opinions on how to deal with SOT during COVID-19.

Results: The response rate was 37.4% (58 of 155). Overall, 84.5% reported an effect of COVID-19 on SOT in Europe. In 49% of these, limited capacity was mentioned, and in 51% the reason for restricted resources was strategic preparedness. As a result, SOT was totally or partially suspended for several weeks. In sum, 93.1% of centers implemented protective measures against COVID-19. Nongovernmental information policies were felt to be adequate in 90%. Continuation of transplant activities was desired by 97% of centers.

Conclusion: The results of this survey suggested a need for more ICU capacity during COVID-19, in order to guarantee adequate and timely treatment of other patient cohorts in surveyed countries.

Keywords: transplantation, COVID-19 pandemic, restrictions, strategic preparedness

Introduction

Coronavirus type 2 is responsible for severe acute respiratory syndrome (SARS-CoV 2), as well as the associated COVID-19, which occurred first in Wuhan, China in December 2019.^{1,2} The virus spread around the world within a few weeks² and became a public-health emergency of international concern at the end of January³ and a pandemic on March 11, 2020.⁴ At that point, the number of new cases in Europe had gone beyond those in China, and cases were doubling (depending on the country) within a few days.⁵ All countries within Europe had confirmed cases of COVID-19 patients and deaths. The most affected countries were Italy, Spain, France, and the UK. In order to prevent further spread of the virus, most European governments established lockdowns, including self-isolation, social distancing, closing schools, and banning of events, which affected >250 million people.⁶ During 2020, lockdowns and further waves of the pandemic alternated and were a never-ending challenge for hospital management and politics. At the time of writing, more than 102 million confirmed COVID-19 cases and over 2 million deaths have been reported worldwide.⁷

Due to the COVID-19 pandemic, new challenges for health-care systems in all countries have arisen and there has been uncompromising prioritization of capacity of hospital facilities and human resources toward COVID-19 patients. Depending

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on the severity of the wave of infections, there was also a shortage of resources by actual capacity (eg, Italy, Spain)^{4,5,7} or by governmental and/or hospital policies in the sense of strategic preparedness (eg, Germany, Austria, Baltic states). In both cases, treatment was restricted for all other patient cohorts but emergencies. Surgical societies drew up lists of procedures that could be performed during the pandemic, including transplantations as life-saving procedures.⁸ The impact of COVID-19 on solid-organ transplantation (SOT) was limited at the beginning of the pandemic^{9–11} and is still unclear and controversial.^{12–18} Furthermore, it is unknown whether it affects the donor pool or whether there is a risk of virus transmission during transplantation. In addition, the risk of infection of living donors and of possibly poorer outcomes for organ recipients is still not clear. Since there are no evidence-based guidelines to deal with COVID-19 and transplantation, many centers have considered restricting (urgency, risk stratification) or even stopping their activities.^{11,19,20}

To evaluate the framework for SOT in Europe during the first lockdown, we conducted an online survey between April 24 and May 15, 2020. A questionnaire to collect information on restrictions on SOT, protective measures, (non)governmental information policies, and individual opinion on how to deal with SOT during COVID-19 was designed.

Methods

Study Population and Survey Conduct

The survey link was distributed between April 24 and May 15, 2020 by email to transplant surgeons at established centers (n=155) within 31 European countries. It was requested that the survey be filled out only once per center. Three reminders were automatically sent at weekly intervals to those who did not respond to the initial email. Only fully completed surveys were able to be returned.

Survey Design and Topics

This questionnaire on COVID-19 and SOT was created at the General, Visceral, and Transplant Surgery division, Medical University of Graz, Austria (Figure 1). The survey comprised multiple-choice questions and yes/no questions. Depending on the answer in the latter, more detailed questions were asked.

The first part of the survey included general questions on location (country) of the transplant center, hospital size, represented by total beds (up to 500, up to 1,000, up to

1,500, up to 2,000, >2000), and both total intensive care unit (ICU) beds and intermediate-care unit (IMC) beds (up to 20, up to 50, up to 100, up to 150, >150).

Furthermore, specific data of transplant centers were evaluated including transplant dedicated capacity, ie, ICU/IMC beds, (up to five, up to ten, up to 20, >20). Moreover, both number of transplantations per year (up to 25, up to 50, up to 100, >100) and number of transplant surgeons (up to five, up to ten, up to 20, >20) were asked about. There was a requirement to fill in the type of organ and the origin of grafts (deceased, living).

Survey Topics

Data on the following topics were collected:

- (I) Restrictions on SOT (questions 3.1–3.8): It was asked whether there had been an effect on the transplant program, and if yes, whether it was caused by shortage of resources or by hospital or governmental policies. In both cases, we intended to find out which resources were limited (beds, equipment, medication, staff) and whether there was a related impairment of the transplant program (same selection, but additionally “only for highly urgent or the sickest patients” in liver, kidney, heart, and lung transplantation). Finally, it was asked if the respondent personally agreed with hospital or governmental policies.
- (II) Protective measures (questions 3.10–3.16): These questions summarized protective measures against COVID-19. It was asked whether there were protective measures in the transplant program. If yes, further details were requested, including isolation of the recipient (if yes, single room, single room + airlock, or single room + airlock + overpressure system), visit ban, maximum number (n=2) of health-care professionals at once with the patient, recipient wearing mask if with health-care professionals (if yes, surgical mask, filtering face piece [FFP] 2 mask, or FFP3 mask), health-care professionals wearing masks if with recipient (if yes, surgical mask, FFP2 mask, or FFP3 mask), and rapid hospital discharge. Furthermore, we asked about COVID-19 PCR testing of the donor and the recipient, and finally we investigated changes in immunosuppressive regimens or prophylactic medication with antibiotics, antimycotics, or antiviral therapy.

EvaSys	Questionnaire on COVID-19 and solid organ transplantation		Electric Paper
General, Visceral and Transplant Transplant Center Graz (TCG) University Hospital, Medical	Questionnaire on COVID-19 and to be filled out by transplant		Landeskrankenhaus - Universitätsklinikum Graz
Bitte so markieren: <input type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> Bitte verwenden Sie einen Kugelschreiber oder nicht zu starken Filzstift. Dieser Fragebogen wird maschinell erfasst. Korrektur: <input type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> Bitte beachten Sie im Interesse einer optimalen Datenerfassung die links gegebenen Hinweise beim Ausfüllen.			
1. General questions			
1.1 Country			
<input type="text"/>			
Hospital size			
1.2 Total number of beds	<input type="checkbox"/> up to 500 <input type="checkbox"/> up to 2000	<input type="checkbox"/> up to 1000 <input type="checkbox"/> > 2000	<input type="checkbox"/> up to 1500
1.3 Total number of ICU-beds	<input type="checkbox"/> up to 20 <input type="checkbox"/> up to 150	<input type="checkbox"/> up to 50 <input type="checkbox"/> > 150	<input type="checkbox"/> up to 100
1.4 Total number of IMC-beds	<input type="checkbox"/> up to 20 <input type="checkbox"/> up to 150	<input type="checkbox"/> up to 50 <input type="checkbox"/> > 150	<input type="checkbox"/> up to 100
2. Transplant program			
2.1 ICU-beds dedicated to transplantation	<input type="checkbox"/> up to 5 <input type="checkbox"/> > 20	<input type="checkbox"/> up to 10	<input type="checkbox"/> up to 20
2.2 IMC-beds dedicated to transplantation	<input type="checkbox"/> up to 5 <input type="checkbox"/> > 20	<input type="checkbox"/> up to 10	<input type="checkbox"/> up to 20
2.3 Organs transplanted in your center	<input type="checkbox"/> Liver transplantation - deceased <input type="checkbox"/> Kidney transplantation - deceased <input type="checkbox"/> Pancreas transplantation <input type="checkbox"/> Heart transplantation - pediatric <input type="checkbox"/> Lung transplantation - pediatric	<input type="checkbox"/> Liver transplantation - living <input type="checkbox"/> Kidney transplantation - living <input type="checkbox"/> Small bowel transplantation <input type="checkbox"/> Lung transplantation - deceased	<input type="checkbox"/> Liver transplantation - pediatric <input type="checkbox"/> Kidney transplantation - pediatric <input type="checkbox"/> Heart transplantation <input type="checkbox"/> Lung transplantation - living
2.4 Number of transplantations per year	<input type="checkbox"/> up to 25 <input type="checkbox"/> > 100	<input type="checkbox"/> up to 50	<input type="checkbox"/> up to 100
2.5 Number of transplant surgeons	<input type="checkbox"/> up to 5 <input type="checkbox"/> > 20	<input type="checkbox"/> up to 10	<input type="checkbox"/> up to 20
3. Effect of COVID-19 on your transplant program			
3.1 ... by shortage of resources	<input type="checkbox"/> yes	<input type="checkbox"/> no	
3.2 limiting factors	<input type="checkbox"/> Beds <input type="checkbox"/> Staff	<input type="checkbox"/> Equipment	<input type="checkbox"/> Medication
3.3 related impairment of your transplant program	<input type="checkbox"/> yes	<input type="checkbox"/> no	
3.4	<input type="checkbox"/> The whole transplant program is stopped <input type="checkbox"/> Liver transplantation - pediatric is stopped <input type="checkbox"/> Kidney transplantation - living is stopped <input type="checkbox"/> Pancreas transplantation - is stopped <input type="checkbox"/> Heart transplantation - pediatric is stopped <input type="checkbox"/> Lung transplantation - living is stopped	<input type="checkbox"/> Liver transplantation - deceased is stopped <input type="checkbox"/> Liver transplantation - only for high urgent or for the sickest patients <input type="checkbox"/> Kidney transplantation - pediatric is stopped <input type="checkbox"/> Small bowel transplantation - is stopped <input type="checkbox"/> Heart transplantation - only for high urgent or for the sickest patients <input type="checkbox"/> Lung transplantation - pediatric is stopped	<input type="checkbox"/> Liver transplantation - living is stopped <input type="checkbox"/> Kidney transplantation - deceased is stopped <input type="checkbox"/> Kidney transplantation - only for high urgent or for the sickest patients <input type="checkbox"/> Heart transplantation - is stopped <input type="checkbox"/> Lung transplantation - deceased is stopped <input type="checkbox"/> Lung transplantation - only for high urgent or for the sickest patients
3.5 ... by hospital or governmental policy	<input type="checkbox"/> yes	<input type="checkbox"/> no	

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15.04.2020, Seite 1/3

Figure 1 Continue.

EvaSys	Questionnaire on COVID-19 and solid organ transplantation		Electric Paper
3. Effect of COVID-19 on your transplant program [Fortsetzung]			
3.6	restricted factors	<input type="checkbox"/> Beds <input type="checkbox"/> Staff	<input type="checkbox"/> Equipment <input type="checkbox"/> Medication
3.7	related impairment of your transplant program	<input type="checkbox"/> yes	<input type="checkbox"/> no
3.8		<input type="checkbox"/> The whole transplant program - is stopped	<input type="checkbox"/> Liver transplantation - deceased is stopped
		<input type="checkbox"/> Liver transplantation - pediatric is stopped	<input type="checkbox"/> Liver transplantation - only for high urgent or for the sickest patients
		<input type="checkbox"/> Kidney transplantation - living is stopped	<input type="checkbox"/> Kidney transplantation - pediatric is stopped
		<input type="checkbox"/> Kidney transplantation - deceased is stopped	<input type="checkbox"/> Kidney transplantation - only for high urgent or for the sickest patients
		<input type="checkbox"/> Pancreas transplantation - is stopped	<input type="checkbox"/> Small bowel transplantation - is stopped
		<input type="checkbox"/> Heart transplantation - pediatric is stopped	<input type="checkbox"/> Heart transplantation - only for high urgent or for the sickest patients
		<input type="checkbox"/> Heart transplantation - is stopped	<input type="checkbox"/> Lung transplantation - deceased is stopped
		<input type="checkbox"/> Lung transplantation - living is stopped	<input type="checkbox"/> Lung transplantation - pediatric is stopped
		<input type="checkbox"/> Lung transplantation - only for high urgent or for the sickest patients	
3.9	Do you personally agree with hospital or governmental policy	<input type="checkbox"/> yes	<input type="checkbox"/> no
3.10	Protective measures against COVID-19 in your transplant program	<input type="checkbox"/> yes	<input type="checkbox"/> no
3.11	... modified standards in your transplant program	<input type="checkbox"/> Isolation of the recipient	<input type="checkbox"/> Visit ban
		<input type="checkbox"/> Recipient wearing mask if together with health care professionals	<input type="checkbox"/> Health care professionals wearing masks if together with recipient
		<input type="checkbox"/> Changes in immunosuppressive regimen	<input type="checkbox"/> Changes in prophylactic medication with antibiotics
		<input type="checkbox"/> Changes in prophylactic medication with antiviral therapy	<input type="checkbox"/> Changes in prophylactic medication with antimycotics
3.12	Kind of isolation	<input type="checkbox"/> Single room	<input type="checkbox"/> Single room and airlock
			<input type="checkbox"/> Single room, airlock and overpressure system
3.13	Recipient wearing mask	<input type="checkbox"/> MNM (mouth and nose mask, surgical mask)	<input type="checkbox"/> ffp2 (N95)
			<input type="checkbox"/> ffp3 (N99)
3.14	Health care professionals wearing masks	<input type="checkbox"/> MNM (mouth and nose mask, surgical mask)	<input type="checkbox"/> ffp2 (N95)
			<input type="checkbox"/> ffp3 (N99)
3.15	COVID-19 PCR-testing of recipients	<input type="checkbox"/> yes	<input type="checkbox"/> no
3.16	COVID-19 PCR-testing for donors	<input type="checkbox"/> yes	<input type="checkbox"/> no
4. Support with relevant information			
Sufficient local information politics			
4.1	Hospital administration	<input type="checkbox"/> yes	<input type="checkbox"/> no
4.2	Physicians chamber	<input type="checkbox"/> yes	<input type="checkbox"/> no
4.3	Governmental	<input type="checkbox"/> yes	<input type="checkbox"/> no
Sufficient national information politics			
4.4	Governmental	<input type="checkbox"/> yes	<input type="checkbox"/> no
4.5	Physicians chamber	<input type="checkbox"/> yes	<input type="checkbox"/> no
4.6	Societies	<input type="checkbox"/> yes	<input type="checkbox"/> no
4.7	OPOs (Organ procurement organization)	<input type="checkbox"/> yes	<input type="checkbox"/> no
Sufficient international information politics			

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15.04.2020, Seite 2/3

Figure 1 Continue.



EvaSys	Questionnaire on COVID-19 and solid organ transplantation		
4. Support with relevant information [Fortsetzung]			
4.8 Governmental (EU)	<input type="checkbox"/> yes	<input type="checkbox"/> no	
4.9 Societies	<input type="checkbox"/> yes	<input type="checkbox"/> no	
4.10 OPOs (Organ procurement organization)	<input type="checkbox"/> yes	<input type="checkbox"/> no	
5. Personal opinion on how to deal with solid organ transplantation during COVID-19 pandemic			
5.1 Continue transplant programs during COVID-19 pandemic	<input type="checkbox"/> yes	<input type="checkbox"/> no	<input type="checkbox"/> based on organ and/or urgency
5.2 ... the following to be continued			
<input type="checkbox"/> Liver transplantation - deceased	<input type="checkbox"/> Liver transplantation - living	<input type="checkbox"/> Liver transplantation - pediatric	
<input type="checkbox"/> Liver transplantation - only for high urgent or for the sickest patients	<input type="checkbox"/> Kidney transplantation - deceased	<input type="checkbox"/> Kidney transplantation - living	
<input type="checkbox"/> Kidney transplantation - pediatric	<input type="checkbox"/> Kidney transplantation - only for high urgent or for the sickest patients	<input type="checkbox"/> Pancreas transplantation	
<input type="checkbox"/> Small bowel transplantation	<input type="checkbox"/> Heart transplantation	<input type="checkbox"/> Heart transplantation - pediatric	
<input type="checkbox"/> Heart transplantation - only for high urgent or for the sickest patients	<input type="checkbox"/> Lung transplantation - deceased	<input type="checkbox"/> Lung transplantation - living	
<input type="checkbox"/> Lung transplantation - pediatric	<input type="checkbox"/> Lung transplantation - only for high urgent or for the sickest patients		
Thanks for your cooperation!			
			

Figure 1 Questionnaire on COVID-19 and solid-organ transplantation.

- (III) (Non)governmental information and policies (questions 4.1–4.10): These questions aimed to evaluate sufficiency of support with relevant information provided by local (hospital administration, physicians' chamber, governmental), national (governmental, physicians' chamber, societies, organ-procurement organization), and international (governmental — European Union (EU), societies, organ-procurement organization) institutions.
- (IV) Personal opinion on how to deal with SOT during COVID-19 (questions 3.9, 5.1, 5.2): The main question was if transplant centers should continue their programs in general or based only on organ and/or urgency. If the latter of possibilities was answered with a “yes”, the specific programs to be continued had to be selected.

Data Management and Statistical Analysis

The questionnaire was collected anonymously and data collected imported automatically and evaluated using the EvaSys program.²¹ Data were displayed as descriptive statistics.

Results

General Data

The response rate was 37.4% (58 of 155) of centers from 17 European countries (Figure 2). Among these, 8% had a total of >2,000, 24.1% up to 2,000, 25.9% up to 1,500, 25.9% up to 1,000, and 15.5% up to 500 beds. Concerning total ICU/IMC beds, 17.2%/8.6% transplant centers had >150 beds, 19%/8.6% up to 150 beds, 27.6%/29.3% up to 100 beds, 25.9%/34.5% up to 50 beds, and 10.3%/19% up to 20 beds, respectively.

General Information on Transplant Centers

All kinds of SOT were represented in the survey (Figure 3). Total transplantations >100 per year irrespective of type of organ were given in 53.4% of centers, up to 100 in 25.9%, up to 50 in 17.2%, and up to 25 in 3.4%. There were >20 transplant surgeons in 5.2%, up to 20 in 27.6%, up to ten in 34.5% and up to five in 32.8% of the surveyed transplant centers. The number of ICU/IMC beds dedicated to

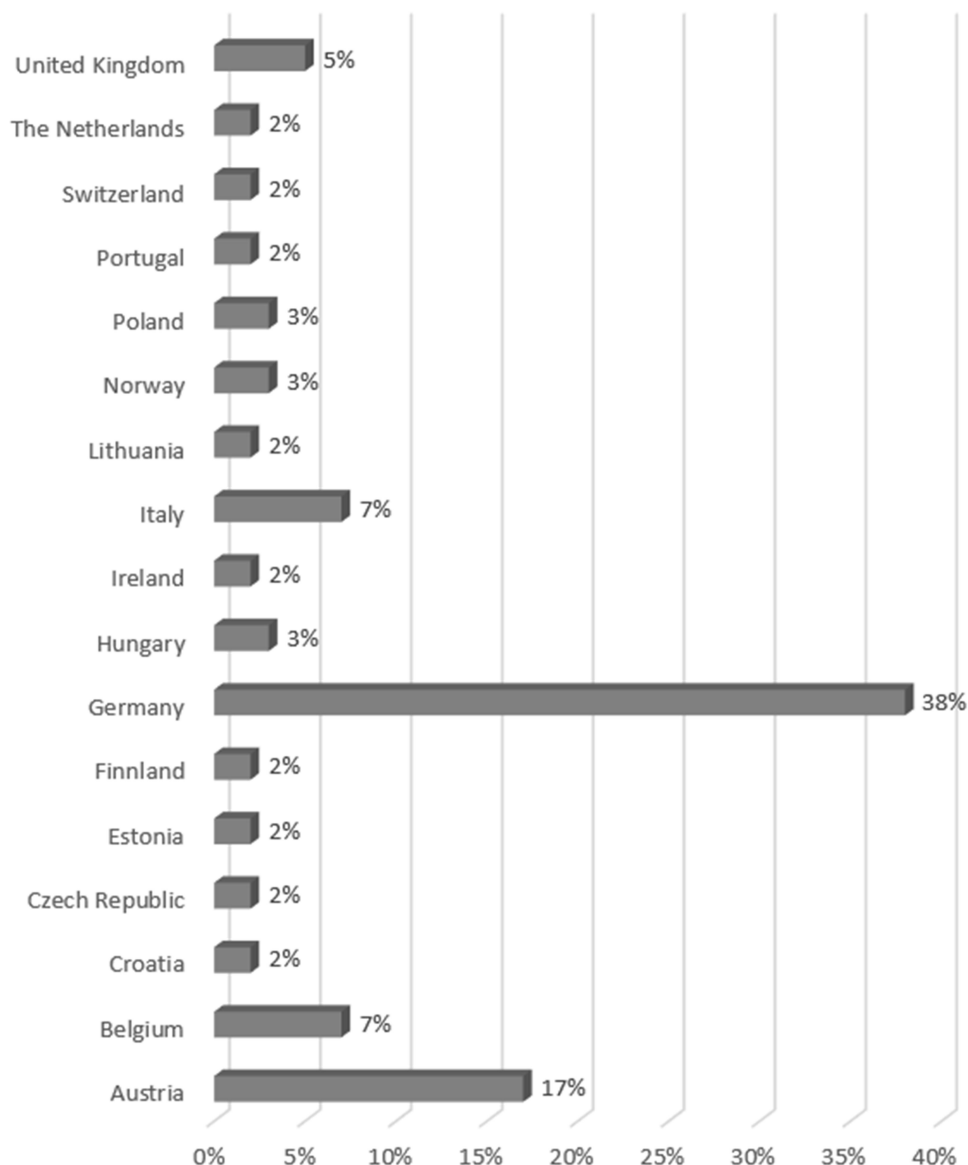


Figure 2 Country (n=17) distribution of completed surveys.

transplantation comprised >20 in 5.2%/5.2% of transplant centers, up to 20 in 6.9%/17.2%, up to ten beds in 34.5%/25.9%, and up to five in 53.4%/51.7%, respectively.

Effect of COVID-19 on SOT

Overall, 84.5% reported an effect of COVID-19 on SOT. In 49% of these (n=24) a current shortage of resources as an effect of the COVID-19 was stated. Limitation factors were beds (83.3%), equipment (25%), and staff (37.5%). Medication was not a restricting factor. In these centers, related impairment of transplant programs was declared in 95.8%. There had been complete suspension of the entire transplant center in 8.7%, of deceased kidney transplantation

in 39.1%, of living kidney transplantation in 65.2%, of pediatric kidney transplantation in 17.4%, of pancreas transplantation in 43.5%, and of small-bowel transplantation in 17.4% (Figure 4). Only the deceased liver-transplant program was not stopped in any center.

Hospital or governmental policies caused an effect of 51% on transplant centers, with related impairment of the programs in 96%. Limitation factors were beds (92%), equipment (20%), and staff (28%), but not medication. Due to the policies, 8.3% of entire transplant programs had been stopped, 50% of deceased kidney transplantation, 66.7% of living kidney transplantation, and 45.8% of pancreas transplantation (Figure 5).

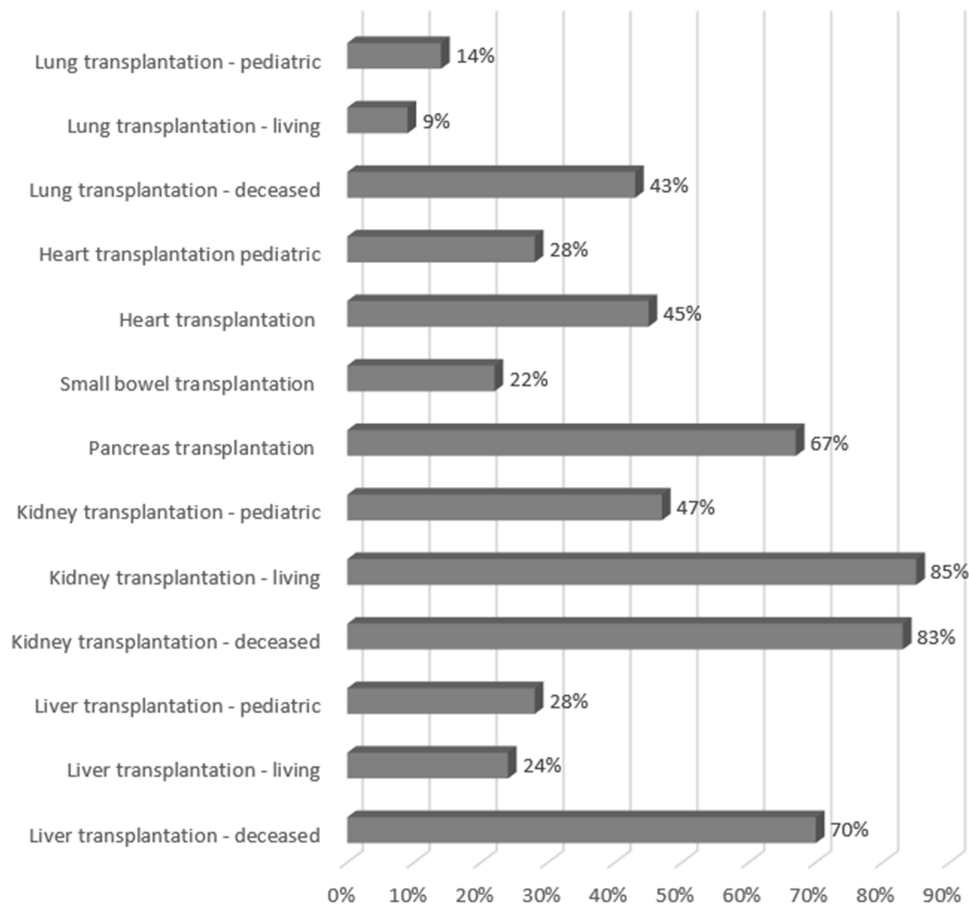


Figure 3 Organs transplanted in centers of respondents.

Due to differing severity of COVID-19 pandemic, health-care systems, and governments among European countries there was a certain heterogeneity between countries concerning the impact on their transplant centers (Table 1).

Respondents from Italy reported an effect of COVID-19 on transplant programs of 100% (50% shortage of resources and 50% hospital or governmental policies). In up to 25%, the entire transplant program had been stopped. In Austria, 60% of resources were limited by hospital and/or governmental policies, in Germany, this was only 22.7%. In Austria, the deceased kidney transplantation program had stopped in 100%, the living kidney program in 83.3%, the pediatric kidney program in 50%, and the pancreas program in 83.3%. In Germany, the deceased kidney transplantation program was continued, but the living kidney program was stopped in 80%, and the pancreas transplantation program in 50%.

A total of 13.8% of transplant centers disagreed with current policies. However, in some European countries there agreement of only 50–60% with hospital or governmental policies concerning COVID-19 (Table 1).

Protective Measures Against COVID-19 in Transplant Centers

Most of the transplant centers (93.1%) implemented protective measures against COVID-19. Recipients were isolated in 64.8% of centers (single room in 71.4%, single room + airlock in 17.1%, single room + airlock + overpressure system in 11.4%). Visit bans were in place in 77.8%, and number of health care professionals at once with recipient had been restricted to two in 40.7% of centers. Further modified standards comprised wearing of masks for both recipient and health-care professionals (surgical mask 85%/83.3%, FFP2 mask 12.5%/14.6%, FFP3 mask 2.5%/2.1% of centers). Changes in immunosuppressive regimen were carried out in only 7.4%, and no changes in prophylactic medication with antibiotic, antimycotic, or antiviral therapy were reported. COVID-19 PCR testing of recipients was found in 93.1% and of donors in 94.8%.

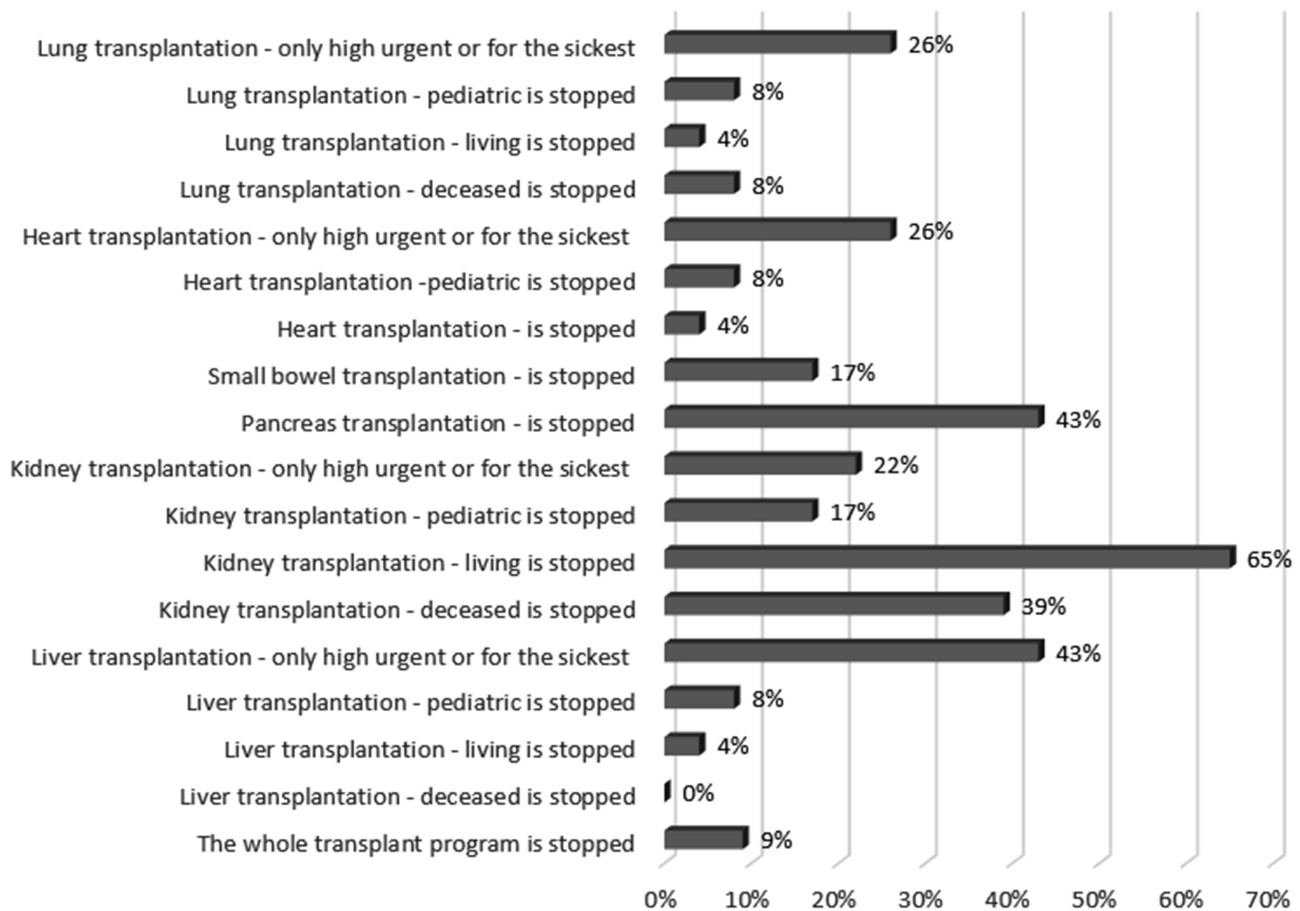


Figure 4 Shortage of resources as effect on transplant programs (n=23).

Feedback on Support with Relevant Information

Respondents felt adequately informed about the topic by local (hospital administration 91.4%, physicians' chamber 77.6%, governmental 77.6% of centers), national (governmental 79.3%, physicians' chamber 75.9%, societies 86.2%, organ-procurement organizations 75.9% of centers), and international (governmental — EU 56.9%, societies 79.3%, organ-procurement organizations 60.3% of centers) information policies.

Personal Opinions on How to Deal with SOT During COVID-19

Of all transplant centers, 96.6% would continue transplant activity in general (52%) during COVID-19 or based on organ and/or urgency (48%).

Discussion

Survey results demonstrated a tremendous impact of COVID-19 on transplant centers in Europe. Related

impairment of transplant activity was caused either by actual shortage of resources or strategic preparedness, given by hospital/governmental policies. Both reasons for restrictions were present to the same extent. Actual impairment by number, however, remains unclear.

This is the first assessment of the impact of COVID-19 on SOT in Europe. Other surveys that have been carried out recently^{22–28} focused on different topics and were carried out only within one or a few countries. A survey with similar question was carried out in the US.²⁹ This survey may be the basis for speculating on the shortage of ICU capacity needed to provide health-care support for both COVID-19 and all other patients in most countries.

Impact of Shortage of Resources on Transplant Centers

At the height of the pandemic, several European countries were affected by total utilization of the capacity of their health systems (eg, Italy, Spain, and France).^{5,7} Both restrictions and even suspension of transplant programs were not

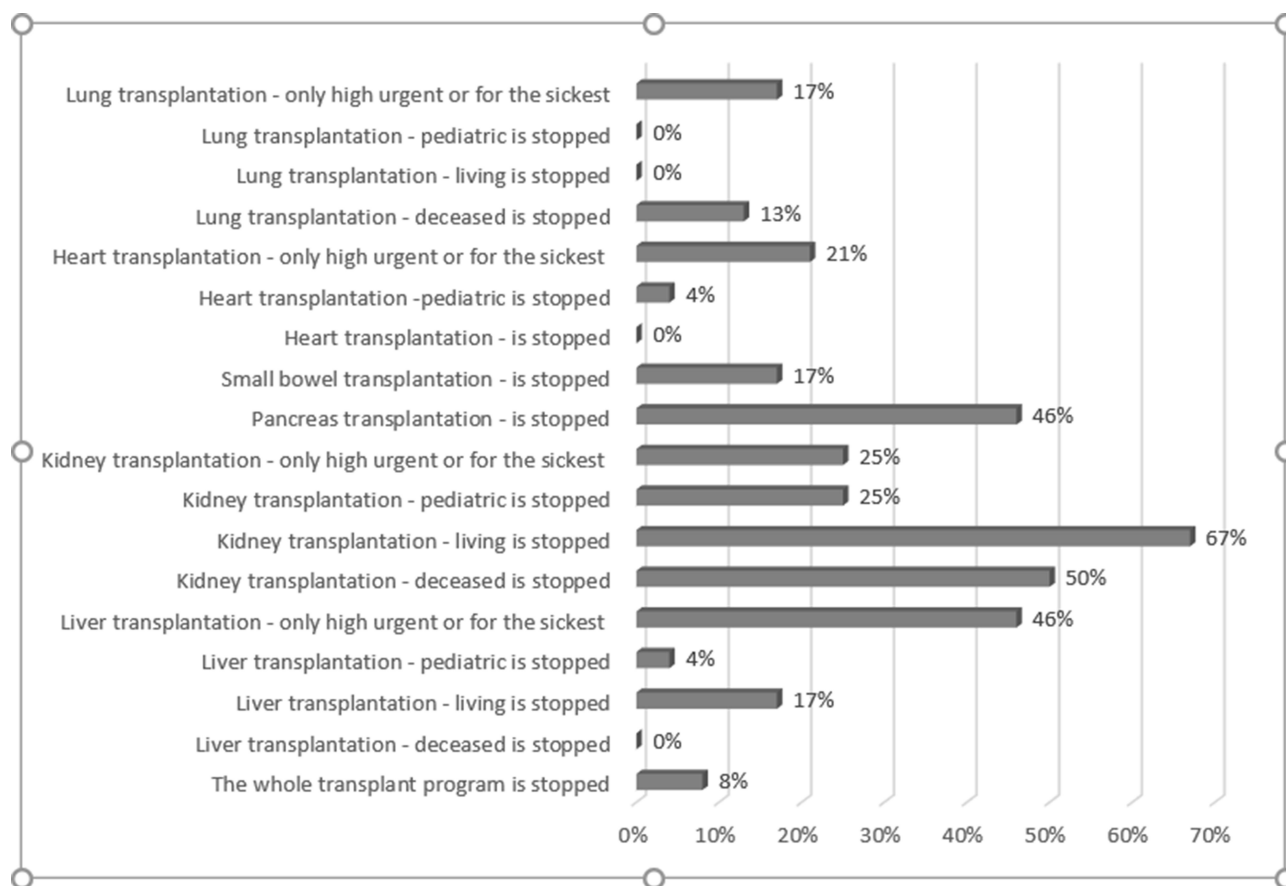


Figure 5 Hospital or governmental policy as effect on transplant programs (n=24).

reflected by the necessity based on the ICU capacity provided (Table 2) in various corresponding countries (eg, Germany). The characteristics of the health-care systems and the socio-demographic needs of the different European countries vary widely, and the measures recommended by the WHO have been applied differently across different countries and regions. During the pandemic, such countries as Germany,

which have more ICU beds per head of population (Table 2), were able to help other European nations that were temporarily or continuously overwhelmed with an excess of cases (eg, Italy). In Italy, ICUs had to be expanded and new hospitals built to cope with the demands of the escalating number of COVID-19 patients. Furthermore, human resources were reorganized and retired professionals and

Table 1 Impact of COVID-19 pandemic on transplant centers and personal opinions of countries with two or more respondents

Country Respondents $n \geq 2$	Impairment of transplant programs by shortage of resources	Impairment of transplant programs by hospital or governmental policy	Agreement with policy	Personal Opinion: continue transplant program (in general, based on organ and/or urgency)
Austria	60%	70%	60%	100% (30%, 70%)
Belgium	75%	100%	50%	100% (50%, 50%)
Germany	22.7%	13.6%	95.5%	95.5% (66.6%, 33.3%)
Hungary	50%	100%	100%	100% (0/100%)
Italy	50%	50%	75%	100% (50%, 50%)
Norway	0	0	100%	100% (100%/0)
Poland	100%	50%	100%	100% (0/100%)
UK	66.6%	66.6%	100%	66.6% (50%, 50%)

Table 2 Case loads (cumulative total in January 2021, WHO COVID-19 Dashboard), COVID deaths/million inhabitants, and ICU beds/100,000 inhabitants of surveyed countries

Country	Cases — cumulative total	COVID deaths/million inhabitants	ICU beds/100,000 inhabitants
UK	3,647,467	1,370	6.6
Italy	2,466,813	1,429	12.5
Germany	2,141,655	639	29.2
Poland	1,478,119	942	6.9
Netherlands	948,933	803	6.4
Czech Republic	940,004	1,458	11.6
Belgium	693,666	1,801	15.9
Portugal	636,190	1,079	4.2
Switzerland	506,775	1,063	11.0
Austria	401,534	834	21.8
Hungary	360,418	1,214	13.8
Croatia	229,054	1,189	4.3
Ireland	187,554	620	6.5
Lithuania	177,166	987	15.5
Norway	60,803	101	8.0
Finland	41,915	118	6.1
Estonia	40,975	295	14.6

volunteers sent to hospitals in critical areas. In this situation, other patients, such as cancer or transplant patients, could no longer be cared for, due to lack of resources, above all limited beds, staff, and equipment. As for our survey, transplant centers in Italy were affected 100% (50% by shortage of resources and 50% by hospital or governmental policies). In up to 25%, whole transplant centers were closed. However, 25% of the responding centers did not agree with health-care policy. All the queried centers would have liked to continue their transplant activity during COVID-19 (52% in general, 48% based on organ and/or urgency) in order to be able to continue caring for their patients. US data comparable to those from Italy were published recently.²⁹ Results of a nationwide survey demonstrated complete suspension rates of living kidney transplantation in up to 71.8% and living liver transplantation in up to 67.7%. Restrictions of deceased kidney-transplantation programs were declared in 84% and of deceased liver-transplant programs in 73.3%. Almost no restrictions were placed on heart- or lung-transplantation programs.

A completely different situation was observed in other European countries, where the severity of the COVID-19 pandemic was not that substantial. In order to be prepared for a possibly extreme COVID-19 situation, resources were kept free for safety reasons and thus restricted. Strategically prepared countries were Austria and Germany, for example, but interestingly there were

differences between them. While in Austria, 60% of resources were limited by hospital and/or governmental policy, in Germany it was only 22.7%. In Austria, the deceased kidney-transplantation program was 100% stopped, while in Germany it was continued. While transplant centers in Germany mostly agreed with hospital or governmental policies, in Austria there was disagreement of 40%. Almost all transplant centers in both countries (Austria 100%, Germany 95.5%) agreed to continue transplantation during COVID-19 in general (Austria 30%, Germany 66.6%) or based on organ and/or urgency (Austria 70%, Germany 33.3%).

Our results showed that the resources of all transplant centers in Europe were more or less affected by COVID-19. The extent of the negative effect on transplantation depended on the severity of the infection wave, but also on strategic measures within individual countries. An important goal for the future must be to learn from the experiences of all countries and develop strategies for the future that can support a reduction in the collateral damage of pandemics on transplant centers.^{30–32} It must be clear that a dramatic increase in patients requires an increase in resources, unless restrictions treating patients with ICU/IMC requirements in need of isolation are accepted.

Another approach to continuing SOT is restriction of treatment to highly selected patients. As an example, the sickest-first strategy could be applied. As an alternative,

the healthiest patients are treated on the assumption of better resistance against COVID-19 infection and thus better survival after transplantation. Data from this survey clearly showed that up to 33.3% of the centers transplanted only highly urgent or the sickest patients. Deceased and pediatric programs should be continued over living transplant programs. However, transplanting only healthier recipients with the best-quality organs and lowest risk of delayed graft function might also be a good strategy.²⁹ When trying to select, some criteria might be considered: kidney transplantation, preemptive transplantation, highly sensitized patients, those with negative cross matching, or higher-acuity patients. In cases of liver transplantation, patients could be stratified on the severity of their illness, first transplants, and those with tumors without other options. For heart and lung transplantation as lifesaving procedures, there were almost no restrictions and there should not be any in future. In any case, COVID-19 recipient- and donor- testing availability is mandatory, and attention should be paid to a low-risk COVID-19 setting (both donor and recipient SARS-CoV2–negative).

Unknown Effects of COVID-19 on SOT

In the middle of March 2020, when the COVID-19 pandemic started, knowledge on the impact of the virus in a transplant setting including immunosuppression was scarce and discouraging.^{19,33,34} Therefore, some transplant centers considered stopping their programs^{11,12,20} or restricting transplantation to highly urgent or risk-stratified patients. Risk stratification was especially difficult, due to pending data or even scores. During the following weeks, many recommendations from transplantation or surgical societies, clinical studies, and case reports were published,^{35–39} enabling transplant centers to get a first overview on the actual risk of the virus for transplant recipients. First experiences of transplant-programs center in Europe demonstrated data with quite good survival of transplanted patients during the outbreak, and no specific reasons to stop transplant programs were found.⁴⁰ Of course, a careful risk–benefit analysis for performing transplantation should be considered, and in particular the risk of COVID-19 infection in transplant recipients has to be minimized. The results of our survey demonstrated that COVID-19 PCR testing of recipients was performed in 93.1% and of donors in 94.8%. Furthermore, most of the transplant centers (93.1%) implemented protective measures against COVID-19 in their transplant programs.

In our center, liver transplantation was safely performed during COVID-19 in a low-risk setting (both donor and recipient SARS-CoV2–negative, low disease–severity recipients [labMELD score <25], and a low donor risk–index graft).⁴¹ However, data concerning the impact of COVID-19 on patients after transplantation are still rare and controversial; therefore, we urgently need data from further studies that could provide important information for the care of transplant recipients.

Conclusion

This is the first survey to give an overview of 58 transplant centers within 17 European countries and their framework for SOT during the COVID-19 pandemic. Results of this survey suggest a desperate need for ICU capacity during COVID-19 in most countries to guarantee adequate and timely treatment of other patient cohorts.

Acknowledgment

We especially thank all responding transplant centers for their kind participation.

Author Contributions

All authors made substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data, took part in drafting the article or revising it critically for important intellectual content, agreed to submit to the current journal, gave final approval to the version to be published, and agree to be accountable for all aspects of the work.

Disclosure

The authors of this manuscript have no conflicts of interest to disclose.

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