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Hospitalisation and life support in the year before and during heart transplantation: a French national study

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ABSTRACT

Objective The objective of this study was to define the characteristics of hospital care use during the year prior to heart transplantation.

Methods A retrospective cohort of heart transplant recipients registered on the national hospital discharge database between 2010 and 2015 was analysed.

Results In this cohort of 2379 heart transplant recipients (mean age: 48 years, 74% men), 91% had been admitted at least once, for at least 1 day, to a short-stay hospital during the year before transplantation (mean: 4.3 days), and 84% had at least one cardiovascular diagnosis (heart failure and cardiogenic shock: 60%). At least one intensive care stay was reported for 61% of patients, a rehabilitation stay was reported for 30%, mechanical circulatory support was reported for 12%, and ventilatory support was reported for 15%. The median interval between admission and transplantation was 5 days (interquartile QI–Q3, 0–16). The hospital mortality was higher for patients not hospitalised before transplantation (18% vs 15%). Their transplantation hospitalisation diagnosis, compared with patients hospitalised before transplantation, was more frequently cardiomyopathy (31% vs 27%) or heart failure (28% vs 18%), and less frequently myocardial infarction (1% vs 12%).

Conclusion This study demonstrates a high hospitalisation rate before heart transplantation and identifies three groups of patients: 1—patients with a high hospitalisation rate and terminal heart failure requiring circulatory support who experienced at least one intensive care unit stay; 2—patients with a history of hospitalisation, mainly for heart disease, without circulatory support requirement; and 3—patients with no pretransplantation overnight stay. These findings provide useful information to evaluate the medical benefits and needs for transplantation, and identify areas for improvement in heart transplantation listing criteria.

Key questions

What is already known about this subject?
► There are no published studies concerning hospital (short and rehabilitation) stays before heart transplantation.

What does this study add?
► One year before heart transplantation, 91% of candidates had been admitted at least once to a short-stay hospital for at least 1 day, and 84% had at least one cardiovascular diagnosis (heart failure and cardiogenic shock: 60%).
► At least one intensive care unit admission was reported for 61% and at least one rehabilitation unit admission was reported for 30%.
► Nevertheless, a mean of 4.3 short-stay hospital stays was observed, with a mean length of stay of 51.5 days.
► The mean time between admission and transplantation was 14 days.
► Reflecting allocation systems, short-term mechanical circulatory support (MCS) was more commonly used in France than in the USA, unlike long-term MCS.

How might this impact on clinical practice?
► This study improves our knowledge of the healthcare pathways and identifies areas for improvement in heart transplantation listing criteria.
► Furthermore, a considerable proportion of patients undergo heart transplantation without a previous hospital stay, which must be taken into account when establishing urgent transplant allocation rules.

INTRODUCTION

The natural history of heart failure (HF) is characterised by episodes of acute decompensation with deterioration of cardiac function after each hospital admission.[1] Nearly 25% of patients hospitalised for HF are readmitted within 30 days in the USA,[2] and 20% are readmitted in France,[3] where the all-cause 2-year readmission rate is 69%, mostly related to comorbidities.[4]

Heart transplantation is the gold standard treatment for carefully selected patients with advanced HF refractory to other treatments[5]; it improves survival and quality of life. However, the limited number of donors and the increasing number of candidates restrict access to transplantation in many countries.[6] In France, the number of newly registered patients on the waiting list increased from 463 (7.2 per million person [pmp]) in 2010

to 621 (9 pmp) in 2015, while the number of transplanted patients increased from 356 (5.5 pmp) to 471 (7.1 pmp).[7] Between 2010 and 2013, 68% of newly registered candidates underwent transplantation within 1 year after registration, and the median waiting time was 3.9 months.[8] Cardiac allocation systems worldwide therefore offer grafts primarily to candidates at the highest risk of waitlist mortality.[9] This policy promotes 'just-in-time' access to grafts, with transplantation considered to be the final treatment in the care pathway for HF. In recent decades, progress has also been made in the pharmacological and electrical treatment of HF and mechanical circulatory support (MCS).[10 11]

However, to our knowledge, little or no information is available about hospital use before heart transplantation or about the use of support devices. This national observational study evaluated hospital stay and patient characteristics according to the presence or absence of acute hospital admission, intensive care unit (ICU) stay and rehabilitation unit admission during the year preceding the transplantation hospital stay (THS).

METHODS
Population
The study population included individuals for whom a THS was reported in the French hospital discharge database (Programme de Médicalisation des Systèmes d'Information [PMSI] - Groupe Homogène de Malades 27C05) between January 2010 and December 2015. This study excluded subjects undergoing combined heart-lung transplantation and heart retransplantation during this period.

Data source
The French hospital discharge database collects information about all hospital stays in public and private acute hospital and rehabilitation services. Hospital diagnoses are coded according to the International Classification of Diseases, 10th Edition. This database also contains information on the medical and surgical procedures performed during the hospitalisation, such as the transplantation itself and the use of life support, such as MCS, inotrope infusions and invasive ventilation. Each of these procedures is coded according to a national classification (Classification Commune des Actes Médicaux).

Access to this database by the Agence de la biomedecine is authorised by the French data protection authority (Commission nationale de l'informatique et des libertés), under conditions limiting the possibility of patient identification. The precision of the intervals between hospital stays is therefore limited to the month, but available intervals in the database, such as length of hospital stay (LOS) and time between admission and transplantation, resolve this limitation.

Data analysis
The THS for each patient was linked, *via* an anonymous identifier, to their other short-stay or rehabilitation hospitalisations during the year preceding transplantation. Only admissions requiring an overnight stay were considered.

The primary diagnosis selected for these admissions corresponded to the principal medical reason for each patient's admission before and during THS. Only cardiovascular diagnoses were considered. The existence of at least one medical or surgical procedure
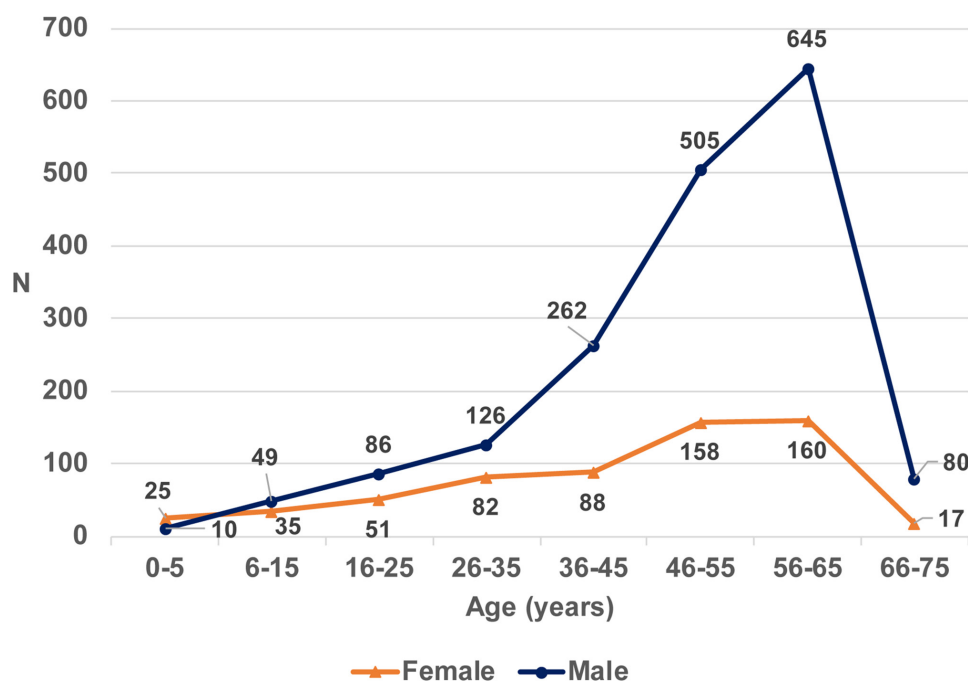

Figure 1 Number of heart transplant recipients in 2010–2015 by age and sex.

A. All patients

B. Patients with at least one hospital stay with a cardiovascular diagnosis before transplantation
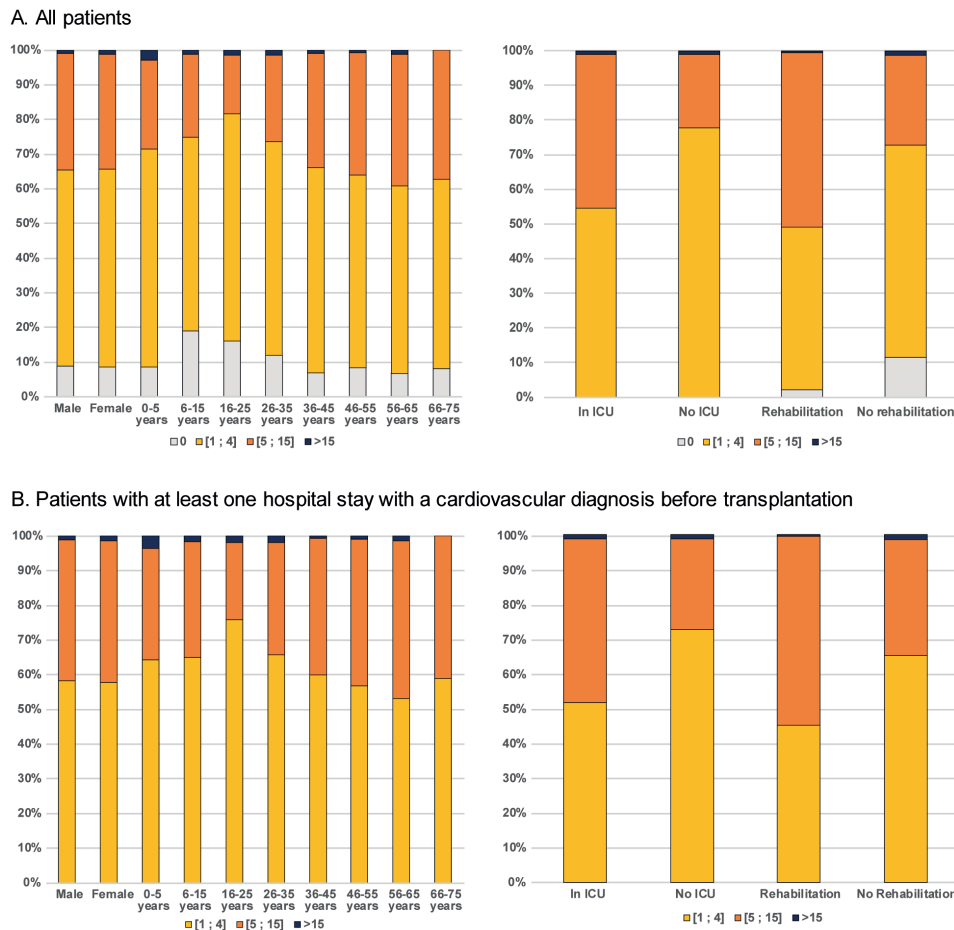

Figure 2 Number of short hospital stays before transplantation by sex, age, intensive care unit (ICU) stay or rehabilitation stay for all patients (A) and those with at least one hospital stay with a cardiovascular diagnosis before transplantation (B).

during hospital stays was also described according to major categories (circulatory or ventilatory assistance, and so on).

Quantitative variables were expressed by mean and SD or the median and the first and third quartiles (Q1–Q3). Pearson's χ^2 test was used for comparisons and lengths of stay were compared by analysis of variance. A p value <0.05 was considered statistically significant.

A Sankey diagram was used to illustrate patient flow according to the presence and types of hospitalisations during the year before heart transplantation. This flow diagram describes patient distribution for each month over the 12-month period, according to hospitalisation, with or without ICU or rehabilitation admission, and includes the monthly flow between the various statuses. For patients with several hospitalisations in different types of facilities during the same month, the status was considered to be ICU when the patient had been admitted to the ICU at least once; otherwise the status was considered to be standard hospitalisation or rehabilitation. Finally, if no hospitalisations were observed during the month, the patient's status was considered to be home.

All analyses were performed with SAS Guide V.7.1 (9.4).

RESULTS

Overall patient characteristics

This study included 2379 recipients who underwent heart transplantation between 2010 and 2015 (mean age: 48±15, 74% men). The total number of heart transplantations increased regularly each year, from 344 in 2010 to 460 in 2015 (figure 1). Male predominance was most notable in the group aged 46–65 years (78%). The mean age of men was 49±14 years and the mean age of women was 43±17 years.

Subgroup patient characteristics

During the year before the THS, 2171 (91%) of the 2379 patients included had at least one overnight hospital stay and 1930 (84%) had at least one overnight hospital stay with a cardiovascular primary diagnosis; 1446 (61%) of the 2379 patients had at least one ICU admission and 724 (30%) had at least one rehabilitation admission. Patients 36 years and older with an ICU or rehabilitation stay more frequently had a short-stay hospital admission before the THS, for all diagnoses or for a cardiovascular diagnosis (figure 2). Patients with at least one hospital stay before transplantation were older than those without a hospital stay before transplantation (48 vs 43 years)

Table 1 Characteristics of transplanted patients and their hospitalisations during the year before the transplantation hospital stay according to the presence (or absence) of at least one acute hospital stay, intensive care unit stay and rehabilitation stay during the year before transplantation

	All	Hospitalisation								
		Hospital stay			Intensive care unit stay			Rehabilitation		
		No	Yes		No	Yes		No	Yes	
n	2379	208	2171		725	1446		1655	724	
Characteristics	%	%	%	P value	%	%	P value	%	%	P value
Age, years, mean (SD)	47.8 (15.1)	43.5 (17.0)	48.2 (14.9)	<0.0001	46.7 (16.4)	48.9 (14.0)	<0.0001	45.9 (16.4)	52.1 (10.4)	<0.0001
0–5	1.5	1.4	1.5	0.0002	2.5	1.0	<0.0001	0.0	2.1	<0.0001
6–15	3.5	7.7	3.1		5.7	1.9		0.0	5.1	
16–25	5.8	10.6	5.3		5.1	5.4		2.1	7.4	
26–35	8.7	12.0	8.4		8.6	8.4		6.6	9.7	
36–45	14.7	11.5	15.0		14.2	15.4		14.8	14.7	
46–55	27.9	26.4	28.0		26.6	28.7		33.4	25.4	
56–65	33.8	26.4	34.5		33.9	34.9		39.0	31.6	
>65	4.1	3.8	4.1		3.4	4.4		4.1	4.0	
Male	74.1	74.5	74.1	0.89	70.5	75.9	0.03	76.0	73.3	0.17
Rehabilitation										
At least one stay	30.4	7.7	32.6	<0.0001	21.8	38.0	<0.0001	–	–	–
Short hospital stay, mean (SD)	4.3 (3.4)	–	4.3 (3.4)	–	3.3 (2.7)	4.8 (3.6)	<0.0001	3.9 (3.5)	5.1 (2.9)	<0.0001
Length of all short stays, days, mean (SD)	10.3 (33.1)		10.3 (33.1)	–	6.0 (7.9)	11.8 (38.0)	<0.0001	14.1 (50.4)	7.8 (12.5)	<0.0001
Length of all short stays with cardiovascular diagnosis, days, mean (SD)	7.0 (6.1)	–	7.0 (6.1)	–	5.7 (4.5)	7.4 (6.4)	<0.0001	7.1 (7.2)	6.9 (3.6)	<0.0001
At least one short stay with:										
Cardiovascular diagnosis	84.5	–	92.6	–	82.8	97.6	<0.0001	80.5	93.8	<0.0001
Cardiomyopathy*	33.7	–	36.9	–	36.1	37.3	0.5828	32.4	36.7	0.0387
Chronic ischaemic heart disease, angina pectoris or myocardial infarction	18.0	–	19.7	–	10.9	24.1	<0.0001	13.2	28.9	<0.0001
Valvular heart disease	3.1	–	3.4	–	1.5	4.3	0.0007	2.4	4.6	0.0053
Congenital heart disease	2.0	–	2.2	–	3.0	1.7	0.0487	2.4	1.1	0.0436
Heart graft (including failures)	0.9	–	1.0	–	1.0	1.0	0.8748	1.1	0.4	0.0854
Heart failure and cardiogenic shock	60.4	–	66.2	–	51.3	73.7	<0.0001	54.0	75.0	<0.0001
Arrhythmia and conduction disorders	19.4	–	21.3	–	13.4	25.2	<0.0001	17.6	23.6	0.0006
Stroke	1.9	–	2.1	–	1.5	2.4	0.1983	1.6	2.6	0.0827
At least one procedure during the stay										
Intra-aortic balloon pump	5.3	–	5.8	–	0	8.7	–	3.9	8.6	<0.0001
Ventricular assist device	7.6	–	8.3	–	0	12.5	–	3.0	18.1	<0.0001
Extracorporeal membrane oxygenation	5.4	–	5.9	–	0	8.9	–	3.3	10.2	<0.0001
Mechanical circulatory support, undetermined	6.7	–	7.3	–	0	11.0	–	2.8	15.5	<0.0001
Mechanical ventilation	14.9	–	16.3	–	0	24.5	–	9.8	26.4	<0.0001
Inotropic perfusion	22.4	–	24.5	–	3.4	35.1	<0.0001	16.3	36.3	<0.0001
Implantable cardioverter-defibrillator	31.6	–	34.6	–	23.3	40.2	<0.0001	24.8	47.0	<0.0001
Arrhythmia, other procedures	23.3	–	25.6	–	14.3	31.2		19.2	32.7	
Coronary artery bypass graft	0.9		1.0	–	0	1.5	–	0.5	1.8	0.003

*Included delated, restrictive andhypertrophic cardiopathies.

(table 1). Patients with an ICU stay (49 vs 47 years) and a rehabilitation stay were also older (52 vs 46 years). Women less frequently had an ICU or rehabilitation stay. Patients with ICU or rehabilitation stays were more often hospitalised before THS (mean number of stays: 4.8 vs 3.3 stays and 5.1 vs 3.9 stays, respectively). Among all admissions before THS with a cardiovascular diagnosis, 60% of patients had a diagnosis of HF and cardiogenic shock, 34% had a diagnosis of cardiomyopathy and 19% a diagnosis of arrhythmia and conduction disorders, 18% had a diagnosis of chronic ischaemic heart disease angina pectoris or myocardial infarction. For patients with at least one ICU stay, these frequencies were 74%, 37%, 25% and 24%, respectively, and for patients with at least one rehabilitation stay these frequencies were 75%, 37%, 24% and 29%, respectively. The mean LOS of all short stays during the year before THS was 10 days and was longer for patients with an ICU stay compared with those without an ICU stay (12 days vs 6 days).

A short-term MCS (intra-aortic balloon pump or venoarterial-extracorporeal membrane oxygenation [VA-ECMO]) was used in 5% of all patients during the year before THS, in 9% of patients with an ICU stay and in 10% of patients with a rehabilitation stay. A long-term MCS (ventricular assist device [VAD]) was used in 8% of cases for all patients, 12% for ICU patients and 18% for rehabilitation patients. An implantable cardioverter-defibrillator was used in 32%, 40% and 47% of patients, respectively.

Transplantation hospital stay

The mean LOS of the THS was 51.5 days (SD=43.7) (table 2). It was significantly longer for patients with hospitalisation before THS compared with patients without hospitalisation before THS (59 vs 51 days) or with a rehabilitation stay (53 vs 47 days). The mean time from admission to transplantation was 14 days (SD=28) and the median time was 5 days. At least 25% of patients were transplanted on the day of admission. This interval was longer for patients hospitalised during the year before THS, with a mean interval of 20 days (SD=29) and a median of 11 days (Q1–Q3: 1.0–25.0).

Overall, 18% of patients died during the THS. This frequency was lower for patients hospitalised during the year preceding transplantation (15% vs 18%), but the difference was not statistically significant. Among the patients discharged alive, 53% were transferred to a rehabilitation facility, 23% to another acute care unit and 24% were discharged home. Discharge to a rehabilitation facility was more frequent for patients with no hospitalisation, ICU stay or rehabilitation stay before the THS.

The most common diagnoses coded during the THS stay were HF or cardiogenic shock (42%), cardiomyopathy (31%), and chronic ischaemic heart disease and angina pectoris (10%). Patients with a hospital stay before THS presented a high rate of myocardial infarction (12%).

Hospital pathway

The distribution of patients according to whether their hospitalisation included admission to ICU and a rehabilitation facility was calculated for each of the 12 months before the THS (figure 3). During the month immediately preceding THS, these rates were 21% for ICU, 19% for hospitalisation and 29% for rehabilitation, while 30% of patients were at home during the last month. The flow between these various states from 1 month to another provides information about the care pathway. During the 12 months before the THS, the proportion of patients at home decreased each month (from 45% 12 months before transplantation to 30% in the month immediately before transplantation); the proportion of patients in hospital increased, with (11% vs 21%) or without (15% vs 19%) ICU admission. The monthly proportion of patients in rehabilitation remained stable, at 29%. The highest flows were from home to hospital, and from hospital to home, as well as from home to ICU (between 4% and 5% each). These flows also varied over time. Flows from rehabilitation to hospital and vice versa were both between 2% and 3%.

DISCUSSION

To our knowledge, this study is the first nationwide study describing the hospital care use and pathways during the year before heart transplantation. It shows that patients receiving heart transplantation are a particular population of patients with HF; their hospitalisation rate before transplantation is high, principally for cardiac diagnosis, and they frequently need life support treatment.

Population and patient characteristics

To be eligible for heart transplantation in France, patients must be registered on the national waiting list (CRISTAL, the French transplantation registry). This registry provides data on transplant candidates and their follow-up. Comparison of the CRISTAL registry and PMSI data shows that 97% of heart transplant recipients listed in CRISTAL during the study period were also identified in the PMSI. The minor differences between the two sources could be due to different patient inclusion dates (date of transplantation in CRISTAL and date of the THS in PMSI), but also to the PMSI coding system.

The age of the patients included in this study was similar to that of transplant recipients in the UK (median age [Q1–Q3]: 49 [36–59])[12] and in the International Registry for Heart and Lung Transplantation (ISHLT) registry (median age [5th–95th percentile]: 54 [25–68]).[13] The proportion of patients older than 55 years (42%) was similar to that in the Eurotransplant area (41.5%), and the proportion of women (26%) was similar to that in the ISHLT (25%), US (26%)[14] and UK (28%) registries.

This study confirmed that heart recipients, very predominantly presenting HF with reduced ejection fraction, are younger (mean 48±15 years) and more often

Table 2 Characteristics of the transplantation hospital stay according to the presence (or absence) of at least one acute hospital admission, intensive care unit stay during acute hospital admission and rehabilitation stay during the year before transplantation

	Hospitalisation	Hospital stay			Intensive care unit stay			Rehabilitation		
	All	No	Yes		No	Yes		No	Yes	
n	2379	208	2171		725	1446		1655	724	
Characteristics	%	%	%	P value	%	%	P value	%	%	P value
Time from admission to transplantation (days)										
Mean (±SD)	14.0 (28.0)	13.4 (27.9)	19.7 (28.5)	0.003	13.9 (25.4)	12.4 (32.1)	0.006	9.8 (20.4)	15.8 (30.5)	<0.0001
Median	5	4.0	11.0		6.0	1.0		1.0	6.0	
Q1	0	0.0	1.0		0.0	0.0		0.0	0.0	
Q3	16	16.0	25.0		16.0	11.0		12.0	19.0	
Missing (n)	178	161	17		7.7	6.9		16.7	3.4	
Length of stay (days)										
Mean (±SD)	51.5 (43.7)	50.9 (43.9)	58.7 (48.0)	0.01	50.5 (39.5)	51.6 (50.0)	0.04	47.4 (37.1)	53.4 (46.3)	0.002
Post-transplant in-hospital outcome										
In-hospital death	17.7	17.9	14.9	0.28	17.6	18.5	0.49	17.5	17.7	0.92
Of those alive at discharge				0.22			<0.0001			<0.0001
Home or other	24.0	23.5	29.4		20.0	30.6		17.4	26.9	
Acute care hospital	23.2	23.4	21.5		23.0	24.2		25.1	22.4	
Rehabilitation	52.7	53.1	49.2		57.0	45.2		57.5	50.7	
Hospital diagnosis for transplantation stay				<0.0001			<0.0001			<0.0001
Cardiomyopathy*	30.9	31.3	26.9		28.1	37.8		27.9	32.3	
Heart failure	27.2	28.1	18.3		29.0	26.2		33.4	24.5	
Cardiogenic shock	14.6	14.5	15.9		16.2	11.2		11.3	16.1	
Chronic ischaemic heart disease and angina pectoris	10.4	10.3	11.5		10.5	9.9		12.8	9.4	
Heart transplantation	5.7	5.7	5.3		5.9	5.4		7.0	5.1	
Myocardial infarction	1.9	1.0	12.0		1.5	0		0.4	2.6	
Valvular heart disease	1.0	1.0	0.5		1.1	0.8		1.0	1.0	
Congenital heart disease	1.9	2.0	1.0		1.3	3.3		0.4	2.5	
Arrhythmia and conduction disorders	1.6	1.7	1.9		2.0	1.0		1.2	1.9	
Other cardiology	1.5	1.5	2.9		1.5	1.5		1.2	1.8	
Other	3.3	2.9	3.8		3.0	2.9		3.2	3.0	

*cardiomyopathy : included delated, restrictive andhypertrophic cardiopathies

men (74%) than either outpatients with chronic HF or patients hospitalised for HF.[15 16]

Hospitalisation characteristics

Admissions
In this study, 91% of patients had experienced an average of 4.6 hospitalisations during the year before the THS; 81% of patients had at least one admission with a cardiovascular principal diagnosis. These rates are much higher than those reported by international studies of patients rehospitalised after a first hospitalisation for HF, but not confined to heart transplant candidates. In Europe, the 1-year readmission rates for patients hospitalised with acute and chronic HF were 44% and 32%, respectively, in the European Society of Cardiology Heart Failure (ESC-HF) Pilot survey,[17] and 22% and 11%, respectively, for readmission for HF in the ESC-HF Long-Term Registry.[18] In the USA, 27% of patients hospitalised with HF were rehospitalised within 30 days and 37% of those
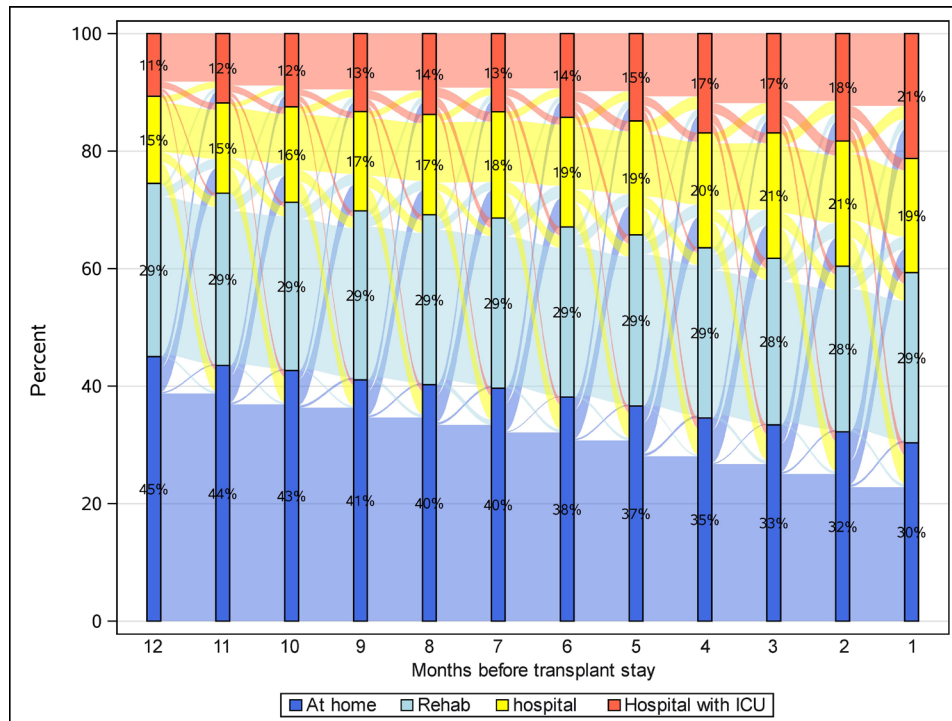
Figure 3 Hospital pathway the year before the transplant-related hospitalisation: Sankey diagram. The histograms represent the proportion of patients according to their location (in hospital with ICU, in hospital without ICU, in rehabilitation or at home). The colours between the bars represent the flow of patients from one compartment to another. ICU, intensive care unit.

rehospitalisations were for HF. Half of all early readmissions were not associated with HF.[19]

Length of stay

The mean LOS for all hospitalisations during the year before transplantation in this study was 10 days, similar to that of patients hospitalised for the first time for HF (9.2 days).[3] The median LOS for registry patients admitted for HF ranged from 4 to 15 days in the Etude Française de l'Insuffisance Cardiaque Aigue (EFICA) study, which only included ICU patients. In the Australian study, patients spent a total of 7.5% of the days in the year before transplantation in hospital.[20] In our study, 66.6% of all patients were admitted to ICU at least once before the THS, compared with 15.2% of patients in the Acute Decompensated Heart Failure National Registry,[21] 22.3% of patients hospitalised for the first time for HF in France[3] and 42.9% of patients in the Observatoire national de l'Insuffisance Cardiaque Aigue (OFICA) study.[22]

Rehabilitation facility

The factors associated with readmission include patient clinical and socioeconomic variables, as well as the quality and organisation of the healthcare system; continuity of care plays a central role during the early period after discharge. Initiatives proposed to reduce rehospitalisation rates include all transitional care interventions, particularly home-visiting programmes and multidisciplinary HF clinic interventions, which reduce all-cause readmissions, while structured telephone support interventions reduce readmissions for HF.[23] In our study, 30% of

patients had been transferred to a rehabilitation facility after discharge from hospital during the year before transplantation.

These findings confirm that the population of candidates for heart transplantation present refractory HF.

Specificities of the transplantation hospitalisation

The mean LOS of the THS, including preoperative and postoperative periods, was 51.5 days, with mean and median intervals between admission and transplantation of 14 and 5 days, respectively. Data from the United Network for Organ Sharing (UNOS) registry show a median LOS (IQR) after isolated heart transplantation in adults discharged alive between 2003 and 2012 of 14 days.[10–20 24] In this cohort of 16 723 patients, 2020 were hospitalised for more than 30 days after transplantation. Among the 17 independent variables associated with a long hospital stay, the highest ORs were observed for recipient glomerular filtration rate ≤30 mL/min, mechanical ventilation before transplantation, 1a UNOS status >21 days and especially ECMO before transplantation. The higher proportion of patients with mechanical ventilation and especially ECMO in our study may explain the difference in the LOS between the patients in our study and those in the UNOS registry.

In-hospital mortality during the THS was 18% and 29-day mortality was 5%. The mortality rate during the THS was 5.7% in Crawford *et al*'s study.[24] The 1-month survival rate after heart transplantation is currently 95% in the USA, 89% in the UK and 88% in France, while the

1-year waiting list mortality is 10% in the UK and 10.7 and 21 per 100 patient-years in the USA and France, respectively. Differences in candidate profiles and management contribute to these differences. The proportion of patients on left ventricular assist device (LVAD) at transplant was more important in the USA than in France (44% vs 9% in 2013), while the percentage of patients on VA-ECMO, prioritised by the allocation system, was higher in France than in the USA (15% vs 1% in 2013), affecting the waiting list mortality. These mortality figures must also be considered in the light of the in-hospital mortality of 3%[25]–27%[26] and with the 1-year postdischarge mortality, which ranges from 17%[17] to 36%,[27] among patients with HF treated medically included in the registries.

In-hospital life support and drug therapy before the transplantation hospitalisation

A low frequency of long-term MCS use was observed in this study, which can probably be partly explained by the rapid access to transplantation of patients on short-term MCS prioritised by the French allocation system.

Comparison with the registries of patients hospitalised for HF showed differences. The percentage of patients with intra-aortic balloon counterpulsation ranged from 0.2% to 4.8% (compared with 5% in France); 3.5%–16.2% had mechanical ventilation (15% in France) and 15%–30% received inotropic infusion (22% in France).[29 30] Longitudinal cohort follow-up studies suggest that the use of inotropic therapy and mechanical ventilation has declined over time.[21] It should be noted that all of these studies were conducted between 2001 and 2009, before the widespread use of long-term MCS. In 2012, the proportion of patients with VAD at transplantation in Australia/New Zealand, the USA and Europe ranged from 9% to 40% (8% in our study).[9]

Strengths and limitations

This nationwide study included a large number of heart transplant recipients over a 6-year period and provides information about their hospital management prior to transplantation. These data could be further enriched by data concerning non-hospital-based healthcare utilisation, including medical and paramedical care and the drugs dispensed. These data could also be individually linked to the national transplantation registry (CRISTAL), which in particular contains clinical information at registration on the waiting list and concerning the transplantation.

One of the strengths of hospital database studies is the comprehensive nature of patient data. However, one of the weaknesses of such studies, apart from the standard limitations intrinsic to coding and data input over a large number of users, is that this coding is designed for financial purposes. Accordingly, some procedures (including transplantation) result in a financial evaluation resulting in more comprehensive data.

The use of this database also explains why only transplant recipients were analysed. We were therefore unable

to analyse the characteristics of transplant candidates who died while on the waiting list, but subsequent analysis of these candidates based on probabilistic record linkage between CRISTAL and the hospitalisation database is planned.

CONCLUSIONS

In this study, 91% of patients had at least one hospitalisation during the year before the THS (81% with a cardiovascular principal diagnosis) and 67% of them experienced at least one ICU stay. More than 25% of patients were transplanted on the day of admission.

In our cohort the THS was long and in-hospital mortality rate during the THS was high. Three groups of patients have been identified: 1—patients with a high hospitalisation rate and terminal HF requiring circulatory support (MCS or inotropic drugs) who experienced at least one ICU stay; 2—patients with a history of hospitalisation, mainly for heart disease, without circulatory support requirement; and 3—patients with no pretransplantation overnight stay. Rehabilitation was more often used in patients from the first group. Finally, the monthly proportion of patients in hospital or ICU, observed during the year before THS, increased over time.

These data improve our knowledge of the healthcare pathways and management of patients requiring heart transplantation. They provide useful information to evaluate the medical benefits and needs for transplantation, and identify areas for improvement in heart transplantation listing criteria.

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