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ORIGINAL RESEARCH ARTICLE

# Effectiveness of a transition plan at discharge of patients hospitalized with heart failure: a before-and-after study

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## Abstract

**Aims** We evaluated the effectiveness of a multidisciplinary transition plan to reduce early readmission among heart failure patients.

**Methods and results** We conducted a before-and-after study in a tertiary internal medicine department, comparing 3 years of retrospective data (pre-intervention) and 13 months of prospective data (intervention period). Intervention was the introduction in 2013 of a transition plan performed by a multidisciplinary team. We included all consecutive patients hospitalized with symptomatic heart failure and discharged to home. The outcomes were the fraction of days spent in hospital because of readmission, based on the sum of all days spent in hospital, and the rate of readmission. The same measurements were used for those with potentially avoidable readmissions. Four hundred thirty-one patients were included and compared with 1441 patients in the pre-intervention period. Of the 431 patients, 138 received the transition plan while 293 were non-completers. Neither the fraction of days spent for readmissions nor the rate of readmission decreased during the intervention period. However, non-completers had a higher rate of the fraction of days spent for 30 day readmission (19.2% vs. 16.1%, $P = 0.002$) and for potentially avoidable readmission (9.8% vs. 13.2%, $P = 0.001$). The rate of potentially avoidable readmission decreased from 11.3% (before) to 9.9% (non-completers) and 8.7% (completers), reaching the adjusted expected range given by SQLape® (7.7–9.1%).

**Conclusions** A transition plan, requiring many resources, could decrease potentially avoidable readmission but shows no benefit on overall readmission. Future research should focus on potentially avoidable readmissions and other indicators such as patient satisfaction, adverse drug events, or adherence.

**Keywords** Readmission; Heart failure; Transitional care; Discharge plan; Potentially avoidable readmission

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## Introduction

Heart failure (HF) is a well-defined but complex clinical syndrome characterized by typical signs and symptoms and caused by structural or functional impairment of ventricular filling or ejection of blood. Its prevalence varies between 10 and 20 per 1000 individuals worldwide. Healthcare expenditure attributed to HF approaches 1–2% in Europe and North America.[1] HF is a chronic disease associated with a high risk of hospitalization and the highest risk of early readmission, reaching 25%.[2–5] In the last decade, reduction of early readmission, defined as a new hospital admission within 30 days after discharge, has become a major goal for healthcare systems as a quality and cost indicator.[6] Moreover, the lack of communication between hospital and community care providers causes ineffective and unsafe discharge.[7,8]

Transition from hospital to home care is recognized as critical to reduce readmission. Transitional care is defined

as a set of actions designed to ensure the coordination and continuity of healthcare.[9] Many interventions on transitional care have been evaluated, such as follow-up call or telemonitoring. Recent reviews showed that no single intervention implemented alone was regularly associated with reduced risk for 30 day readmission. Effective interventions are complex and should reinforce patient self-care. They tend to be more comprehensive, extend beyond the hospital stay, and have the flexibility to respond to individual patient's needs.[10–12]

Reviews focusing on readmission of patients with HF conclude that structured telephone support, multidisciplinary HF clinics, and home-visiting programmes can potentially reduce readmission, but strength of evidence is low or lacking for 30 day readmission and of varying degrees for 3–6 months' readmissions.[13] Currently, the major limitations and weaknesses of the literature on transitional care are the variations in definition of the interventions, the need for better evidence, and the high variability of healthcare settings. It makes a broad implementation of specific interventions difficult.[11,13]

It is clear, however, that even the best intervention could not prevent all readmissions. Halfon *et al*. defined potentially avoidable readmissions (PARE) as unforeseen readmissions for a previously known affliction. They validated the SQLape® (Striving for Quality Level and Analyzing of Patient Expenditures) algorithm for identification of PARE with a sensitivity and specificity up to 96%. On the basis of the Swiss national healthcare register, SQLape® allows estimating the range of adjusted expected rate of PARE in a defined population.[14] As for all-cause readmissions, HF condition is also associated with a high risk of PARE.[15] Readmission is expressed as a rate: the number of readmissions divided by the number of hospitalizations. However, the burden of readmission is better assessed by the length of stay (LOS). Higher LOS is associated with higher costs and complications such as hospital-acquired infections or deconditioning.[16]

### Objectives

Our objective was to assess the effectiveness of a multimodal care transition plan to reduce the burden of 30 day all-cause readmissions among adult patients hospitalized with HF in a general internal medicine department. We chose the fraction of days spent in hospital because of a readmission (days spent in readmission over all days spent in hospital during the study periods) as primary outcome (*Figure A1*). The secondary outcomes evaluated the effectiveness of this transition plan on the PARE.

## Methods

Our study followed a before-and-after design with a retrospective pre-intervention cohort of HF patients and a prospective intervention cohort of HF patients. We added a non-equivalent non-intervention control group composed of all other hospitalized patients during the same period and planned a sensitivity analysis.

The study was conducted in the Department of Internal Medicine at the University Hospital of Lausanne, Switzerland. Between 2011 and 2013, the department discharged, on average, 3842 patients annually. They were mainly admitted from the emergency department (92.3%) and mostly discharged to home (57.3%).

Enrolment began 1 November 2013 and ended 30 November 2014. Patients could be enrolled at each hospitalization. Patients were eligible if they were at least 18 years old, had HF as an active diagnosis, and were discharged to home. HF was defined according to the European Cardiology Society definition[17] or the presence of the appropriate *International Classification of Diseases, Tenth Revision* codes in the medical record (I09.9, I11.0, I13.0, I13.2, I25.5, I42.0, I42.5 to I42.9, I43.x, I50.x, and P29.0). The study excluded patients undergoing chronic haemodialysis, asymptomatic HF stated as New York Heart Association functional class 1, and hospitalizations rejected by the SQLape® algorithm (i.e. living abroad).

The local human research ethics committee reviewed and authorized the protocol (reference number: 278/13). In case of failure to obtain a signed consent form, the patient received usual care.

### Transition plan

A multidisciplinary team of senior physicians, clinical pharmacists, and experienced nurses developed the 11 interventions composing the transition plan. None was part of the usual care, and the team operated the transition plan independently from physicians in charge. The details are given in *Table 1* and illustrated in *Figure A2*.

### Data collection

We collected patient characteristics, setting of hospitalization, and diagnosis from the medico-administrative database of the hospital. We ensured identical inclusion and analysis of before and after groups by using diagnosis coded after discharge from the discharge summary. We therefore avoided a selection bias. The transition team had no access to the statistical analysis results until the end of the study.

### Outcomes

The primary outcome measure was the fraction of days spent in hospital because of a readmission within 30 days after discharge, based on the sum of all days of hospitalization

**Table 1** Transition plan

| Components | Description | Comment and references |
|---|---|---|
| Targeted therapeutic education | On the basis of existing material of the Swiss Heart Foundation for the patient,[18] the nurse provided a structured focused education on self-monitoring, instability signs, and compliance. | *Self-monitoring as weight or breath is associated with less hospitalization. Self-care improves outcomes and should be promoted*.[19–21] |
| Caregiver therapeutic education | The nurse gave the same education to the caregivers, if the patients had dementia or language issue. | *Caregivers have specific demands related to HF patients: physical limitations, medication, symptoms monitoring, regime, or disturbed sleep*.[22] |
| Medication reconciliation at admission | The clinical pharmacist collected three sources of information to build the best available list of home medication, certified during an interview with the patients. | *Pharmacist's interventions reduce the morbidity and mortality associated with heart failure by extending his role from professional guidance to the delivery of continuity of care*.[23] |
| Medication reconciliation at discharge | The clinical pharmacist reviewed and proposed improvement of the discharge prescription, on the basis of the medication reconciliation on admission. The patients, the outpatient pharmacy, and the GP received a commented medication plan. | |
| Set-up of an appointment with the GP | The nurse strongly encouraged the patients to visit their GP within 7 days after discharge, by helping them and reminding them during follow-up calls. | *Follow-up appointment prior to discharge strongly protects against readmission*.[24] |
| Notification of the GP | The nurse sent a message including discharge date, diagnosis, and medication to the GPs to improve their awareness. | *Communication with the GP is central for continuity of care and to reduce the risk of rehospitalization*.[25] |
| Community nurses notification | If the patients benefited from community nurses services, they were informed about the transition plan either in writing or by phone. | *Poor communication between community nurse and physician is associated with an increased risk of hospital readmission among high-risk patients*.[26] |
| Patient-centred discharge instructions | Before discharge, patient's awareness was challenged with three questions: What is my diagnosis? What is my medication? When and where is my next appointment? | *Interactive communication strategy improves the comprehension of the patient*.[27,28] |
| Follow-up call | The nurse called the patients at the 3rd, 7th, and 18th days after discharge, using a structured interview to identify instability signs, motivate the patients to self-monitor, and, if needed, to call their GPs. The calls were supervised by the senior physician. | *Counselling and monitoring through frequent telephone follow-up reduce significantly admissions for heart failure*.[29] |
| Optional consultation | To overcome unavailability of GPs, the patients might ask for a follow-up visit at hospital, within the week after discharge. | *Early follow-up visit after discharge may be effective to reduce all-cause readmission, emergency department visits, and mortality*.[30] |
| Hotline | During office hours, the patients could call the nurse for any reason. | *Patient hotline provides an effective complementary intervention to follow-up calls*.[31] |

GP, general practitioner; HF, heart failure.
The transition plan was provided by a trained nurse acting as a coordinator. The medication reconciliations were performed by a pharmacist. All cases were discussed with a senior physician as clinical supervisor.

(illustrated in *Figure A1*). In case of a second readmission, the first readmission was analysed as an index hospitalization and the patient was included twice. We also measure the 30 day all-cause readmission rate.

The secondary outcomes were (i) the fraction of days spent in hospital because of a PARE based on the sum of all days of hospitalization, (ii) the rate of PARE and the comparison to the adjusted expected interval calculated by SQLape®, and (iii) the readmission-free survival estimates.

## Data analysis

We defined two cohorts of HF patients, one for the pre-intervention period and one for the intervention period. Within the intervention period cohort, we also distinguished the hospitalizations of HF patients who received the transition plan ('receivers') from those who did not complete the plan ('non-completers').

The SQLape® software version 2014 (SQLape SARL, Switzerland), including gender, age, admission mode, LOS, diagnosis, procedures, and other variables—was used to identify PARE and calculate adjusted expected range of PARE.[32]

Descriptive measures of variables were calculated and presented as means and standard deviations. $\chi^2$ test and Wilcoxon tests were used to compare patients' characteristics between pre-intervention and intervention periods. We used a multivariate logistic regression to compare readmissions and PARE. We used STATA 14 (Stata Corp, College Station, TX, USA) to perform the analysis.

Readmission data from all patients hospitalized in our department of internal medicine were collected during the study period to detect general trend of readmission. A sensitivity analysis comparing patients who benefited from the transition plan (receivers vs. non-completers) was performed.

# Results

*Figure 1* shows the flow diagram of screening and enrolment of participants. In the pre-intervention period, 1441 hospitalizations were eligible. In the intervention period, 431 hospitalizations were included for analysis. In 293 out of 431 hospitalizations, patients (non-completers) did not complete the transition plan: 130 were diagnosed for HF after screening, 111 were discharged before enrolment, and 52 refused to give their consent. The remaining 138 patients received the transition plan.

*Table 2* shows characteristics of patients and hospitalizations during the pre-intervention and intervention periods. Patients were similar except for age: patients in the intervention period were significantly older (+1.8 years, *P*-value 0.016). However, the multivariate analysis did not identify age as a significant variable.

## Completion of the transition plan

Actions taking place right before discharge had a lower rate of completion. On average, the transition team needed

**Figure 1** Flow diagram of screening and enrolment of participants. Medical records were screened according to discharge date and diagnosis codes. Hospitalizations rejected by the SQLape algorithm were excluded. HF, heart failure; NYHA 1, New York Heart Association functional class 1 (asymptomatic HF); PARE, potentially avoidable readmission.

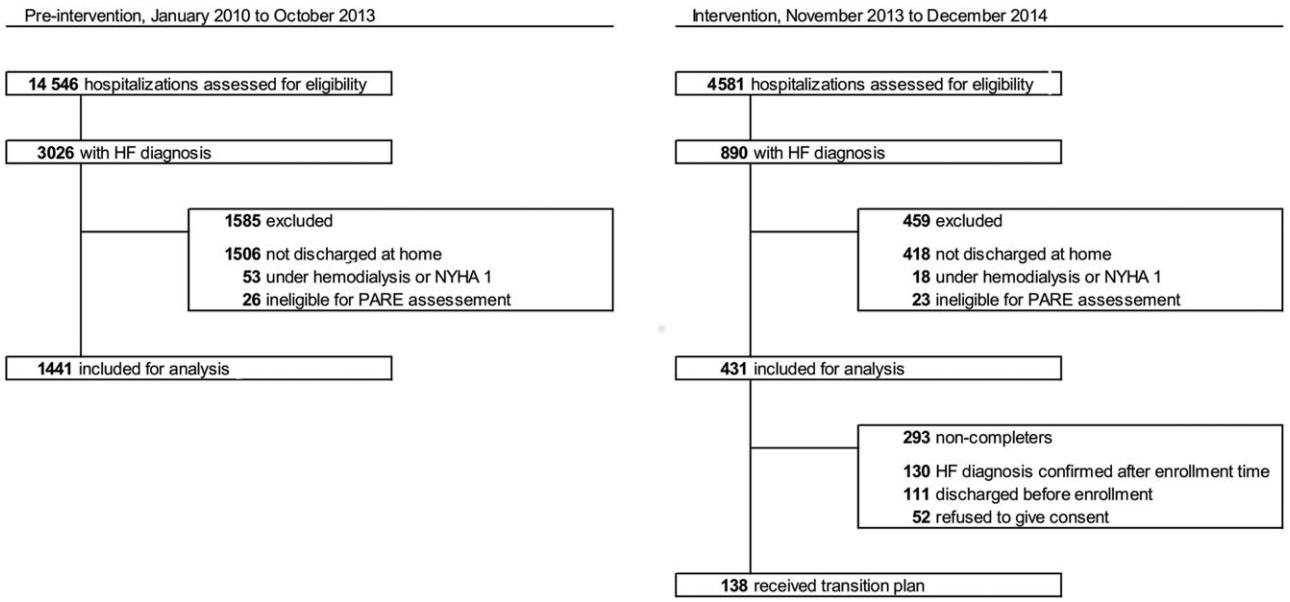


**Table 2** Characteristics of the 1441 hospitalizations studied during the pre-intervention period and 431 in the intervention period

| | Pre-intervention period | | Intervention period | | |
|---|---|---|---|---|---|
| | | % | | % | *P*-value |
| Number of hospitalizations (*n*) | 1441 | | 431 | | |
| Patient characteristics | | | | | |
| Mean age (years old ± SD) | 76.4 ± 12.6 | | 78.2 ± 12.4 | | 0.016[a] |
| Female | 661 | 45.9 | 203 | 47.1 | 0.653 |
| Married | 669 | 46.4 | 186 | 43.2 | 0.232 |
| General insurance[b] | 1299 | 90.1 | 397 | 92.1 | 0.220 |
| Lives in the same sanitary region as hospital | 1172 | 81.3 | 344 | 79.8 | 0.481 |
| Incident hospitalization | | | | | |
| Admission | | | | | |
| Unplanned admission | 1373 | 95.3 | 407 | 94.4 | 0.474 |
| Need of urgent care (E.S.T score ≤ 2) | 907 | 66.0[c] | 264 | 65.0[c] | 0.726 |
| Admission on weekend | 270 | 18.7 | 81 | 18.8 | 0.979 |
| Admission by night | 435 | 30.2 | 147 | 34.1 | 0.123 |
| First complaint at admission | | | | | |
| Chest pain | 154 | 10.7 | 48 | 11.1 | 0.792 |
| Dyspnoea | 748 | 51.9 | 210 | 48.7 | 0.246 |
| Arrhythmia | 94 | 6.5 | 19 | 4.4 | 0.106 |
| Shock | 33 | 2.3 | 6 | 1.4 | 0.252 |
| Other | 346 | 24.0 | 123 | 28.5 | 0.057 |
| Unavailable | 66 | 4.6 | 25 | 5.8 | 0.301 |
| Hospitalization | | | | | |
| Average length of stay (days ± SD) | 15.4 ± 12.4 | | 15.5 ± 12.4 | | 0.487 |
| >8 medications at discharge | 1044 | 75.4 | 324 | 77.9 | 0.305 |
| ≥4 hospitalizations within the last year | 357 | 24.8 | 121 | 28.1 | 0.168 |
| Principal diagnosis | | | | | |
| Congestive heart failure | 624 | 43.3 | 186 | 43.2 | 0.957 |
| Acute myocardial infarct | 95 | 6.6 | 28 | 6.5 | 0.944 |
| Pneumonia | 42 | 2.9 | 9 | 2.1 | 0.355 |
| Respiratory failure | 90 | 6.2 | 21 | 4.9 | 0.290 |
| Atrial fibrillation or flutter | 64 | 4.4 | 18 | 4.2 | 0.814 |
| COPD | 40 | 2.8 | 11 | 2.6 | 0.802 |
| Sepsis | 24 | 1.7 | 7 | 1.6 | 0.953 |

COPD, chronic obstructive pulmonary disease.
[a]*P*-value considered as significant.
[b]Non-general insurances include private and semi-private insurance, more expensive, allowing daily senior attending physician visit and a single-bed room.
[c]Data were available for 1375 (pre-intervention period) and 406 (intervention period) hospitalizations. Echelle Suisse de Triage (E.S.T) Swiss triage scale from 1 to 4. Level 2 patients must be treated in <20 min.

3.25 h of work to complete one transition plan. The medication reconciliation was the most time-consuming task. Moreover, overhead time (administration, visiting wards, screening, meeting, and supervision of team) accounted for 5 to 6 h per opening day. *Table A1* shows the different rates of realization of the components of the transition plan.

## Thirty-day readmissions of heart failure patients and general population

For HF patients, the per cent of days spent in hospital because of a 30 day readmission during the intervention period reached 18.1% (1213/6689 days), significantly higher than that

**Table 3** Outcomes

| | Pre-intervention period | Intervention period | *P*-value |
|---|---|---|---|
| Sum of days spent in hospital by HF patients | 22 235 | 6689 | |
| Days due to any readmission within 30 days | 3451 (15.5%) | 1213 (18.1%) | <0.001 |
| Days due to a PARE within 30 days | 2553 (11.5%) | 805 (12.0%) | 0.520 |
| Hospitalizations of HF patients | 1441 | 431 | |
| Followed by any readmission within 30 days | 276 (19.2%) | 91 (21.1%) | 0.368 |
| Followed by a PARE within 30 days | 163 (11.3%) | 41 (9.5%) | 0.293 |
| Range of adjusted expected rate of PARE | 7.6–9.0% | 7.8–9.1% | N/A |

N/A, not applicable; PARE, potentially avoidable readmission.
The ranges of adjusted expected rate of PARE are calculated with the SQLape® (Striving for Quality Level and Analyzing of Patient Expenditures) algorithm.

in the pre-intervention period, which was at 15.5% (3451/22 235 days, *P*-value < 0.001; *Table 3*). The rate of hospitalizations followed by a readmission within 30 days was higher during the intervention period (21.1% vs. 19.2%, *P*-value 0.368).

However, during the same periods, 30 day readmission also increased in the general population hospitalized in the department of internal medicine. The per cent of days spent in hospital by patients without HF because of a 30 day readmission was 17.6% (13 617/77 461 days) in the pre-intervention period and significantly increased to 18.9% (4763/25 188, *P*-value < 0.001) during the intervention period. The rate of readmission of patients without HF increased as well (18.4% vs. 19.9%, *P*-value 0.134) but was not significant (*Figure 2*).

**Figure 2** Rates of hospitalizations followed by a 30 day readmission: comparison of the pre-intervention and intervention periods among hospitalizations of patients with HF (on the right) and hospitalizations in our internal medicine department of patients without HF (on the left) after being discharged to home. Hospitalizations of patients with HF show an increased rate of all cause readmissions and a decreasing rate of PARE. This leads to a significant reduction of the ratio PARE/total readmissions (*P*-value 0.020). During the study period, overall readmission rate increased, while PARE rate remains stable. Red range stands for adjusted expected range of PARE in each group, according to the SQLape® algorithm. PARE, potentially avoidable readmission.

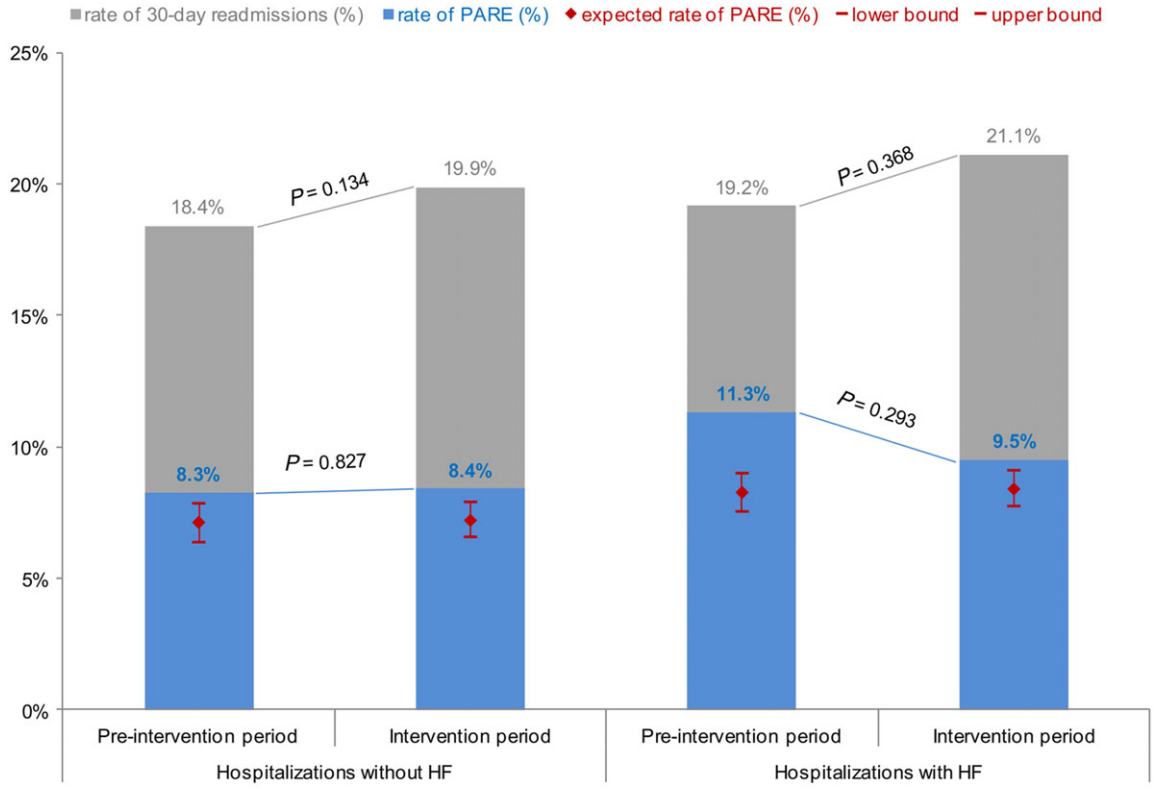



**Table 4** Sensitivity analysis: comparison of the 'non-completers' vs. 'receivers' groups in the intervention period

| | Non-completers | Receivers | *P*-value |
|---|---|---|---|
| Sum of days spent in hospital by HF patients | 4435 | 2254 | |
| Days due to any readmission within 30 days | 851 (19.2%) | 362 (16.1%) | 0.002 |
| Days due to a PARE within 30 days | 585 (13.2%) | 220 (9.8%) | <0.001 |
| Hospitalizations of HF patients | 293 | 138 | |
| Followed by any readmission within 30 days | 60 (20.5%) | 31 (22.5%) | 0.637 |
| Followed by a PARE within 30 days | 29 (9.9%) | 12 (8.7%) | 0.692 |
| Range of adjusted expected rate of PARE | 7.8–9.2% | 7.7–9.1% | N/A |

N/A, not applicable; PARE, potentially avoidable readmission.
The ranges of adjusted expected rate of PARE are calculated with the SQLape® (Striving for Quality Level and Analyzing of Patient Expenditures) algorithm.

### Potentially avoidable readmissions of heart failure patients

The per cent of days spent in hospital because of a PARE was similar in the pre-intervention and intervention periods (11.5 vs. 12.0%, *P*-value 0.520; *Table 3*). The rate of hospitalizations followed by a PARE decreased from 11.3% (163 PARE/1441 hospitalizations) in the pre-intervention cohort to 9.5% (41 PARE/431 hospitalizations, *P*-value 0.293) in the intervention cohort. Although this difference is not significant, this rate approached the adjusted expected range of 7.8–9.1% PARE, calculated by SQLape® (*Figure 2*). Moreover, the ratio of PARE over total readmissions is significantly reduced, meaning—after adjustment for age, sex, sanitary region, and frequency of hospitalization—the risk of PARE is reduced to half (adjusted odds ratio 0.55, *P*-value 0.020).

### Sensitivity analysis

*Table 4* details the results of the sensitivity analysis in the intervention cohort, between receivers and non-completers. The per cent of days spent in hospital because of a 30 day readmission was significantly lower in the receivers group (16.1% vs. 19.2%, *P*-value 0.002). The two groups show no significant difference in rate of readmission (8.7% vs. 9.9%), but the PARE rate of the receivers group lies in the adjusted expected range given by SQLape® (7.8–9.1%; *Figure 3*).

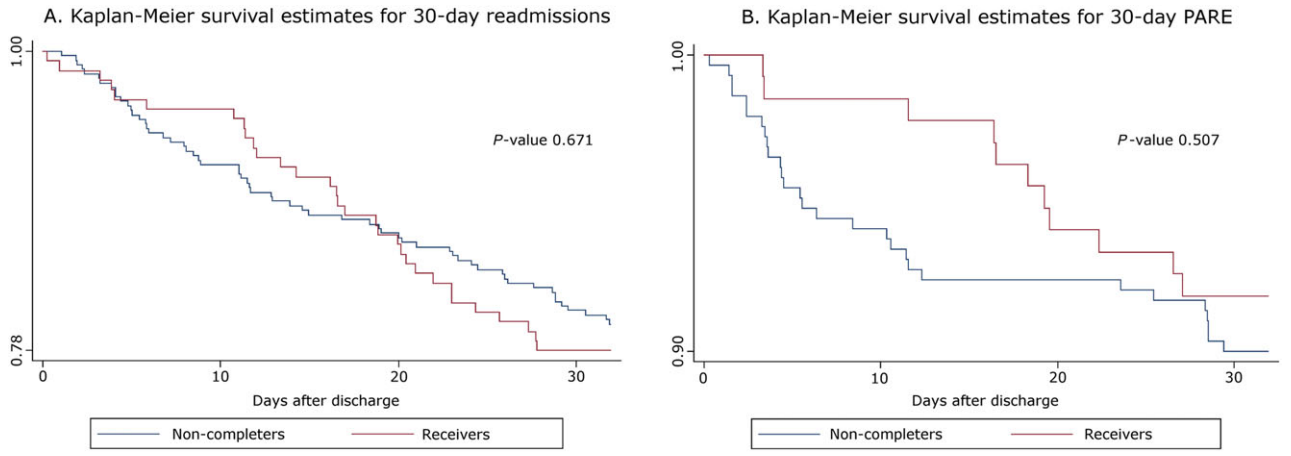
## Discussion

Our before-and-after study aimed to evaluate the impact of a transition plan for HF patients on 30 day readmissions and on PARE. The results highlighted that the transition plan for HF patients discharged from hospital to home failed to reduce 30 day readmissions, for either the primary outcome (per cent of days spent in readmission) or the rate of readmission. However, the rate of PARE decreased from 11.3% to 9.5% but did not reach significance. Furthermore, we found in the comparison of receivers versus non-completers group that the PARE rate significantly decreased from 11.1% to 8.7% in the group who received the transition plan.

As seen in other studies, reaching significance on readmissions rate in transition care studies is challenging.[33] We identified other studies evaluating similar interventions, although transition care highly depends on local healthcare systems. A randomized controlled trial of an outpatient inter-professional management programme for HF patients in Switzerland had a non-significant increased rate of readmission in the intervention group.[34] In the BEAT-HF study, a large randomized controlled trial, the combination of telemonitoring and transition care also failed to reduce 30 day readmission.[35] The systematic review of Feltner *et al*. found little evidence in favour of interventions reducing early readmission but confirms the benefit of multidisciplinary HF clinics on 6 month readmission.[13]

The outcome measure for transition care is usually the readmission rate, because it is an indicator of the disease and symptoms control, and the efficiency of care. However, not all readmissions are preventable: Unavoidable chronic conditions, such as HF, socio-economic status, elderly, or external factors, lead to repeated admissions.[36,37] For example, an overcrowded medical unit (and overloaded staff) could press for anticipation of discharge before complete clinical recovery and favour readmissions. For this reason, it is important to evaluate the impact of transition care on PARE. Given the increasing pressure to improve quality and the financial incentives associated with quality measures in general, a beneficial effect on PARE is particularly welcome. Patients at risk

**Figure 3** Readmission-free survival estimates between the receivers and non-completers groups. Both (A) and (B) show no significant difference at 30 days. PARE, potentially avoidable readmission.



for PARE may be identified before discharges using the HOSPITAL score.[38,39] However, to date, no intervention studies have been able to demonstrate a 30 day decrease in PARE. Our transition plan was able to demonstrate a decrease of PARE that reached the adjusted expected range given by SQLape®. Furthermore, the time to readmission for PARE was delayed. This information is important only if the quality systems focus on readmissions at 15 or 20 days and not at 30 days. Recently, an intervention (during and/or following hospital discharge) targeting patients at high risk of readmission has demonstrated a decrease risk of 15 day readmission.[40] However, to obtain such a benefit, money and time must be invested. We describe later the difficulties we have encountered.

The selection of patients is very demanding. The transition team identified each new HF patient at admission and also screened every single medical record every day to identify new diagnosis during hospitalization, based on European Society of Cardiology criteria for HF.[17] We included patients hospitalized with HF and going home. Unfortunately, orientation at discharge was subject to sudden changes: Even if a stay in a rehabilitation centre was planned during the entire stay, the physician in charge might decide on the last day—with the patient and the family—to let the patient go home; we had no chance to provide a discharge plan in a short time. Conversely, if a patient is suddenly not going home because he or she was transferred to surgery, or even died, we lost the efforts put in the discharge plan. We spent many resources by providing a complete or partial transition plan for a surplus of 53 enrolled patients who could not be included afterwards because of late decision to not discharge to home,[28] death before discharge,[7] ineligibility for PARE assessment,[5] and initiation of haemodialysis.[2]

The second lesson learned is that the transition plan, tailored to fit patients' needs, presented a high rate of completion and therefore confirmed its feasibility, although this complexity was inevitable. Time is the critical resource for our plan. For example, we performed complete medication reconciliation, at admission and discharge, but it required ~1.5 h per patients. Overall, patients gave a positive feedback about the plan, particularly the follow-up phone calls.

Should we drop transition care because of the difficulty to show the effectiveness of a transition plan? We believe that the benefit cannot just be a marginal reduction of readmission rate. Decrease of stress related to hospitalization, better adherence to medication, and reduction of post-discharge adverse drug event could also be indicators of success.[41]

### Strengths and limitations

Our study resents a major effort to improve transition care at discharge of HF patients. Because of consecutive inclusion with few exclusion criteria, the transition team worked in real conditions. Investigators were blinded until the end of the intervention period, because outcome measures (readmission) were extracted from medico-administrative database afterwards. Furthermore, physicians in charge of the patient were independent of the transition team.

Our study has limitations. Despite daily review of all medical record, one-third (138) only of the targeted population received the intervention, potentially explaining the non-significant outcome. As discussed earlier, screening and identifying patients for the transition plan were challenging, like in other studies.[42] Less autonomous patients, confused patients, and foreign language-speaking patients were more likely to refuse to give consent, inducing a selection bias. It would likely have been the same issue while implementing a permanent transition team. Secondly, the before-and-after study design is subject to bias: The population characteristic and the overall readmission rate varied across time. However, although it increased significantly during the study, age was not identified as a significant variable in a multivariate analysis. It might be that older people receive more support and therefore compensate the risk for 30 day readmission. Moreover, age is not part of the HOSPITAL score predicting readmission.[39] Still, we cannot exclude coding and calculation variation.

Thirdly, readmissions in another hospital, death outside hospital, and patient moving abroad could not be identified in the retrospective pre-intervention cohort, because our outcome measurements were based on the available medico-administrative database.

Finally, we performed our study in a single hospital, so there is a limit to external validity. Some systematic reviews already recognized this limitation.[10] However, an effective transition plan would have to be adapted to local healthcare system, while being based on clinical guidelines related to HF.

## Conclusions

A transition plan is feasible and is likely to improve transition to home for HF patients. It requires, however, many resources, and the benefit represented by the reduction of readmissions is not clear. Future research should focus more on PARE than on readmission rate, and on other indicators like stress related to hospitalizations, patient satisfaction, adverse drug events, or adherence.

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## Conflict of interest

None declared.

## Author contributions

Conception or design of the work: A.G., O.L., N.R., C.N., P.V., A-C.G., M.U.
Obtainment of funding: A.G.
Data collection: A.G., C.N., N.R., D.G.
Data analysis and interpretation: A.G., O.L.
Drafting of article: A.G.
Critical revision of the article: A.G., N.R., D.G., C.N., P.V., A-C.G., M.U., G.W., O.L.
Final approval of the version to be published: A.G., N.R., D.G., C.N., P.V., A-C.G., M.U., G.W., O.L.

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## Data sharing statement

Requests should be sent to A. Garnier (antoine.garnier@chuv.ch) and are conditional on a signed data transfer agreement.

## Appendix

**Figure A1** Burden of readmission: more than just a readmission rate, primary outcome takes lengths of stay into account. We considered the ratio of days spent in readmission over all days spent in hospital during the study periods. Each line corresponds to a patient, and each box is a hospitalization with various lengths of stay. Grey boxes are hospitalizations considered as 30 day readmission.

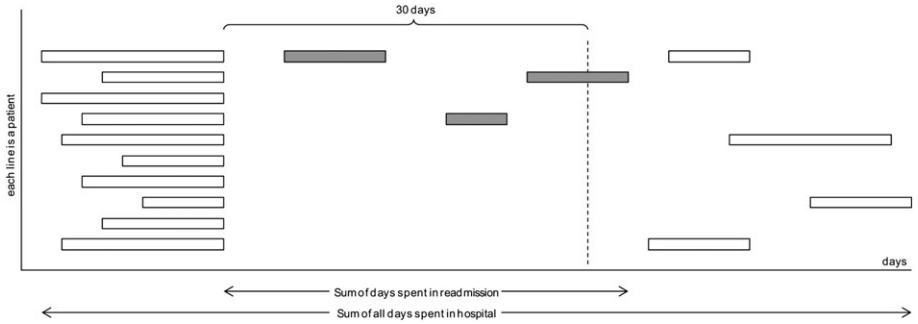


**Figure A2** Timeline of the transition plan. Each intervention is described in the *Table 1*. Many are taking place after decision of discharge and are therefore challenging to provide in time. GP, general practitioner.

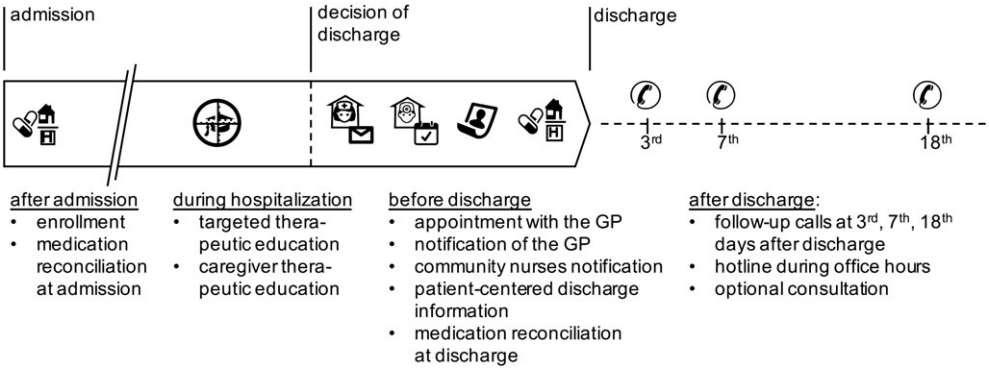

**Table A1** Rate of completion of the transition plan

| Interventions | Performed | % |
|---|---|---|
| Number of transition plan performed (*n*) | 138 | |
| Early during hospitalization | | |
| Targeted therapeutic education | 137 | 99 |
| Caregiver therapeutic education (if present) | 25 | 18 |
| Medication reconciliation at admission | 111 | 80 |
| Before discharge | | |
| Medication reconciliation at discharge | 101 | 73 |
| Set-up of an appointment with the primary care physician | 123 | 89 |
| Notification of the primary care physician | 134 | 97 |
| Community nurse notification (if present) | 80 | 58 |
| Patient-centred discharge instructions | 125 | 91 |
| After discharge | | |
| Follow-up call at Day 3 | 133 | 96 |
| Follow-up call at Day 7 | 135 | 98 |
| Follow-up call at Day 18 | 133 | 96 |
| Optional follow-up consultation | 1 | 1 |

Breakdown of the components of the transition plan. Hotline utilization is not reported. Caregiver therapeutic education and community nurse notification were only performed when a partner was present.

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