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## **A safe handover for every patient: an interrupted time series analysis to test the effect of a structured discharge bundle**

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3 **A safe handover for every patient: an interrupted time series analysis to test the effect of a**  
4 **structured discharge bundle**  
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## Abstract

**Objective** Patient handovers are often delayed, patients are hardly involved in their discharge process and hospital-wide standardized discharge procedures are lacking. The aim of this study was to implement a structured discharge bundle and to test the effect on timeliness of medical and nursing handovers.

**Design** Interrupted time series with six pre-intervention and six post-intervention data collection points (September 2015 through June 2017).

**Setting** Internal medicine and surgical wards.

**Participants** Patients ( $\geq 18$  years) admitted for more than 48h to surgical or internal medicine wards.

**Intervention** The Transfer Intervention Procedure (TIP), containing four elements: within 48h after admission planning discharge date, arrangement of post-discharge care, preparing handovers and personalized patient discharge letter; and a discharge conversation 12-24h before discharge.

**Outcome measures** The number of medical and nursing handovers sent within 24h. Secondary outcomes were the median time between discharge and medical handovers, length of hospital stay (LOS) and unplanned readmissions.

**Results** Pre-intervention 1039 and post-intervention 1052 patient records were reviewed. No significant change in levels and slopes was observed in the number of medical and nursing handovers sent within 24h. The median (interquartile range) time between discharge and medical handovers decreased from 6.15 (0.96-15.96) to 4.08 (0.33-13.67), but no significant difference in levels and slopes was found. No intervention-effect was observed for LOS and readmission. In subgroup analyses, a reduction of 5.6 days in the median time between discharge and medical handovers was observed in hospitals with high protocol adherence and much attention for implementation.

**Conclusion** Implementation of a structured discharge bundle did not lead to improved timeliness of patient handovers. However, large inter-hospital variation was observed and an intervention effect on the median time between discharge and medical handovers was seen in hospitals with high

1  
2  
3 protocol adherence. Future interventions should continue to create awareness of the importance of  
4  
5 timely handovers.  
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9 **Trial Registration:** Dutch Trial Registry: NTR5951  
10

### 11 12 13 **Strengths and limitations of this study** 14

- 15 • This study aimed to implement a structured discharge bundle to improve patient handovers  
16 for every patient.
- 17 • The study design, i.e. Interrupted Time Series Analysis, provided valuable information on pre-  
18 intervention trends, which strengthens the results.
- 19 • Sensitivity analysis provided important insight into the inter-hospital variation and  
20 differences in intervention effects among hospitals.
- 21 • Although it would have been informative, data on the content of medical handovers were  
22 not collected, as not on accurateness and timeliness of medication handovers.
- 23 • It was not possible to evaluate percentages of compliance with the study protocol and,  
24 although in line with the observed efforts, the process evaluation with the project leaders  
25 might have been an overestimation.  
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## Introduction

As hospital stays have become shorter and full recovery often takes place at home,<sup>1</sup> a safe transition from hospital to home or nursing home has become more and more important. Besides, a rising number of older chronically ill patients who move along the care continuum, requires continuity of care<sup>2 3</sup>. However, transitions from hospital to primary care settings are still considered a high-risk process. Patients are discharged with little coordination or follow-up and are hardly involved in their own discharge process.<sup>4 5</sup>

Inadequate transitions may have serious implications for patient safety and quality of care. Post-discharge adverse events such as medication errors, can be the consequence of insufficient or lacking communication between hospital and primary care providers, thereby contributing to higher resource use and unplanned readmission rates<sup>6-11</sup>. In fact, unplanned readmission rates in the first month post-discharge are as high as 20%<sup>12</sup> and a recent study shows that half of them are deemed preventable.<sup>11</sup>

The root of a safe transition from hospital to home or nursing homes is a timely transfer of accurate medical discharge information<sup>8 13</sup>. The general practitioner (GP) can only take over responsibility for a patient safely, when receiving a medical handover containing accurate information on, e.g., medications, and follow-up.<sup>13</sup> Nonetheless, a review of Kripalani et al. showed that discharge letters are often not available, lack important information or are not sent in a timely manner<sup>8</sup>. Also, a more recent study performed in 20 Dutch hospitals showed that in 10% of cases discharge letters were missing and the remainder was on average sent after one week,<sup>14</sup> even though unplanned readmissions most frequently occur within the first week post-discharge<sup>15</sup>.

Previous studies that aimed to improve patient handovers, mainly focused on specific high risk populations and targeted patient-related factors<sup>16-18</sup>. Although such interventions on individualized discharge planning or transitional care have been effective in reducing readmission<sup>16 17</sup> and post-discharge mortality rates,<sup>18-20</sup> organizational factors that form the basis of a safe handover

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2  
3 should also be optimally arranged<sup>13 21</sup>. In fact, in order to ensure patient safety and continuity of care,  
4  
5 early discharge planning, a structured discharge process and timely handovers might be essential<sup>13 21</sup>  
6  
7 <sup>22</sup>. Besides, given that patients are often unprepared at time of discharge and uncertainties about  
8  
9 aspects such as treatment or medication may exist,<sup>5</sup> patient education, e.g., in terms of a proper  
10  
11 discharge conversation, should also be an important aspect of the discharge process<sup>6 7</sup>.  
12

13  
14 The aim of this study was, therefore, to implement a structured discharge process, the  
15  
16 Transfer Intervention Procedure (TIP), in eight hospitals. The TIP contains four elements: within 48h  
17  
18 after admission planning the discharge date, arrangement of required post-discharge care, and  
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20 preparing patient handovers and a personalized patient discharge letter; and holding a discharge  
21  
22 conversation 12 tot 24h before discharge. We tested whether the TIP improved timeliness of medical  
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24 and nursing handovers and investigated the effect of the TIP procedure on length of hospital stay and  
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26 unplanned readmissions within 30-days post-discharge.  
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## 30 **Methods**

### 31 *Study design and setting*

32  
33 We evaluated the implementation of the TIP discharge bundle in an interrupted time series (ITS),  
34  
35 which is the strongest design when a randomized controlled trial is not feasible<sup>23 24</sup>. The trial  
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37 protocol<sup>25</sup> was based on the recommendations for ITS studies,<sup>23</sup> and we adhered the SQUIRE  
38  
39 guidelines for quality improvement reporting.<sup>26</sup> Outcomes before and after implementation of the  
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41 TIP bundle were compared, by conducting six pre-intervention and six post-intervention  
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43 measurements. During the implementation period (two months) no measurements were conducted.  
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45 Throughout the Netherlands, one university and seven regional teaching hospitals participated and  
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47 the TIP was implemented at one of their surgical and one of their internal medicine wards. February  
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49 2016, a kick off meeting was held. Between March 2016 and November 2016, hospitals started with  
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51 implementation. During this period, regular meetings were held to provide feedback, discuss  
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3 implementation, and share experiences. Data collection started September 2015 and ended June  
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5 2017 (Supplement Table 1). All patients (aged  $\geq 18$  years) admitted for more than 48h were eligible  
6  
7 for inclusion. The Medical Ethics Research Committee confirmed that the Medical Research Involving  
8  
9 Human Subjects Act did not apply to this research project and official approval was not required.  
10

### 11 12 13 *Discharge procedures in the Netherlands*

14  
15 In the Netherlands, primary care standards are relatively high and basically every person has a  
16  
17 general practitioner (GP). When a person is hospitalized, responsibility is taken over from the GP by  
18  
19 the medical specialist. After discharge, patient care becomes responsibility of the GP again. It is  
20  
21 policy for hospitals to provide patient handovers to the GP. However, there are no clear guidelines  
22  
23 for hospitals how to arrange their discharge process. The Dutch healthcare inspectorate,<sup>27</sup> indicated  
24  
25 that standardized discharge procedures are lacking and errors that occur during handovers are often  
26  
27 resolved informally.  
28

29  
30 The current study was part of a large national program, initiated by the Dutch Ministry of  
31  
32 Health, Welfare, and Sport (abbreviated in Dutch: VWS): 'Addressing Waste in Health Care'. This  
33  
34 program was set up in order to reduce inefficiencies in the provision of health care. As part of this  
35  
36 program, a TIP study group was established, comprising a study coordinator, two supervisors, one  
37  
38 clinical epidemiologist, a policy officer from the Ministry of VWS and local project leaders from the  
39  
40 eight participating Dutch hospitals that implemented the TIP bundle. Regular meetings were held to  
41  
42 report results and provide feedback, to discuss implementation, share experience and learn from  
43  
44 each other's practices.  
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### 46 47 48 49 *Intervention*

50  
51 Figure 1 illustrates how the TIP bundle forms the basis of a safe handover from hospital to primary  
52  
53 care for every patient, and if applicable, for patients discharged with post-discharge care or for  
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3 complex patients who require a case manager or transitional care. As previously described,<sup>25 28</sup> the  
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5 TIP bundle was developed using input from focus group meetings with professionals, patient surveys  
6  
7 and literature. The TIP discharge bundle consists of four elements: 1) planning the discharge date  
8  
9 within 48 hours after admission and communication of the discharge date with the patient, 2) start  
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11 with arrangement of required post-discharge care within 48 hours after admission; 3) prepare  
12  
13 patient handovers (medical, medication, nurse) and personalized patient discharge letter (PPDL<sup>29</sup>)  
14  
15 within 48 hours after admission, 4) plan a discharge conversation with the patient to explain  
16  
17 information from the PPDL 12-24h before discharge. The TIP bundle was available on checklists for  
18  
19 nurses and physicians.  
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#### 23 *Patient and Public Involvement*

24  
25 Our research question was developed from the perspective that patients are discharged with little  
26  
27 coordination or follow-up and that they are often unprepared at time of discharge<sup>4 5</sup>. Patients were  
28  
29 involved in the construction of the TIP discharge bundle, which was based on, among others, patient  
30  
31 satisfaction surveys<sup>25 28</sup>. Further, in a previous study in which the PPDL was developed and  
32  
33 implemented, patient satisfaction with the PPDL was also assessed<sup>29</sup>.  
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#### 38 *Protocol adherence*

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40 A process evaluation was conducted with the project leaders to investigate protocol adherence,  
41  
42 implementation strategies and attention paid to implementation. Elements that were considered  
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44 included leadership and education of project leaders, projects group, extent of implementation of  
45  
46 the discharge bundle, and education of physicians and nurses. Feedback points were awarded for all  
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48 elements and for the extent to which the hospital complied to a certain element, e.g., for every  
49  
50 person present at the kick off meeting or for every project meeting that was held. When a hospital  
51  
52 partly complied to an element, e.g. discharge summaries were provided instead of a PPDL or  
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3 feedback on timely handovers was only provided to nurses, 0.5 feedback points were awarded. It  
4  
5 was not possible to evaluate percentages of compliance with discharge conversations, planning  
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7 discharge dates and arrangement of post-discharge care within 48h since these aspects were not  
8  
9 reported in patient records. Hospital policies regarding these elements were assessed.

### 10 11 12 13 *Outcome measures*

14  
15 Our primary outcome was the number of medical and nursing handovers sent within 24h. Medical  
16  
17 handovers also include medication handovers and we considered the time that these handovers  
18  
19 were sent to the GP. The median time between discharge and the medical handover was considered  
20  
21 as secondary outcome. Further, secondary outcomes were length of hospital stay (LOS) and rates of  
22  
23 unplanned readmission within 30 days. Variables were all collected from patient files. Data regarding  
24  
25 patient characteristics included: demographics, admission ward and medical data (i.e. presence of  
26  
27 polypharmacy, comorbidity,<sup>30</sup> number of hospitalization in the six months prior to current  
28  
29 hospitalization). All data were reported and analyzed anonymously.

### 30 31 32 33 34 *Sample size calculation*

35  
36 Based on the findings of a previous study<sup>28</sup> we expected to find a reduction of 78% in the time  
37  
38 between discharge and medical handovers sent. We conducted a power analysis with a number of  
39  
40 patients based on the number of hospital beds at the participating wards and feasibility with regards  
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42 to data collection, which was set at 11 patients. In a simulation study with 16 wards, each  
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44 contributing 65 patients, we estimated the power to be approximate 91% to demonstrate a  
45  
46 reduction of 78% in time until sending the medical handover, assuming that the intraclass correlation  
47  
48 coefficient does not exceed 0.05.

### 49 50 51 52 53 *Statistical analysis*

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3 Descriptive characteristics of patients were calculated using proportions, means and standard  
4  
5 deviations (SD), or medians and interquartile ranges (IQR), as appropriate. Chi-squared analysis and  
6  
7 the Mann Whitney test were used to compare pre-intervention and post-intervention patient  
8  
9 characteristics. To analyze the intervention-effect, generalized least square analysis were performed  
10  
11 to assess changes in level and slope of the regression lines before and after implementation<sup>24</sup>. A  
12  
13 change in level is defined as the difference between the observed level at the first post-intervention  
14  
15 time point and that predicted by the pre-intervention time trend. A change in trend is defined as the  
16  
17 difference between post- and pre-intervention slopes. We explored models with no, a first order  
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19 autoregressive correlation between consecutive data collection periods, and longer autocorrelation  
20  
21 structures. We used the Akaike Information Criterion (AIC) as an estimator of the relative quality of a  
22  
23 model and we report the results from the best fitting model. Correction for baseline imbalances as  
24  
25 potential confounders led to results with similar estimates and identical interpretation. Based on the  
26  
27 extent of protocol adherence and the feedback points awarded, subgroup analyses were performed  
28  
29 to assess the intervention effect on the number of medical handovers within 24h and the median  
30  
31 time between discharge and medical handovers. Statistical analyses were performed using SPSS  
32  
33 Statistics ©, version 24.0, and Rstudio, version 1.0.136 (© 2009 – 2016 Rstudion, Inc).

## 38 **Results**

39  
40 A total of 2091 patient records (1039 pre- and 1052 post-intervention) were reviewed in order to  
41  
42 investigate the effect of the Transfer Intervention Procedure (TIP) on the timeliness of medical and  
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44 nursing handovers, length of hospital stay (LOS) and unplanned readmission within 30 days. Overall  
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46 patients had a mean age (SD) of 68.1 (16.6) and 46.4% were male (table 1). There were significant  
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48 differences between the pre-, and post-intervention group with regard to polypharmacy and the  
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50 ratio of acute/elective hospitalizations and these variables were considered as potential  
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3 confounders. However, correction for these potential confounders did not provide better models  
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5 than the presented models.  
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#### 8 9 *Protocol adherence*

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11 Implementation strategies and protocol adherence are summarized in Supplement Table 1. Based on  
12  
13 the process evaluation, three subgroups were identified. Subgroup 1 (hospitals 4 and 8), >30  
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15 feedback points, paid considerable attention to implementation and there was relatively high  
16  
17 protocol adherence. In subgroup 2 (hospitals 1-3, and 5), 20-30 feedback points, there was relatively  
18  
19 high protocol adherence but moderate attention to implementation. In subgroup 3 (hospitals 6 and  
20  
21 7), <10 feedback points, nearly no attention was brought to implementation and there was low  
22  
23 compliance.  
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#### 26 27 28 *Medical and nursing handovers*

29  
30 In the total study population, no intervention effect was found on the percentage of medical  
31  
32 handovers being sent within 24h after hospital discharge to the GP: 22.7% medical handovers were  
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34 sent within 24h pre-intervention, 29.1% post-intervention and no significant difference was observed  
35  
36 in the levels and slopes between the pre-intervention and post-intervention period. The median  
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38 (interquartile range, IQR) time between discharge and medical handovers decreased from 6.15 (0.96-  
39  
40 15.96) pre-intervention to 4.08 (0.33-13.67) post-intervention. An absolute effect directly after the  
41  
42 implementation of the intervention of -0.25 days was found. No significant difference in the levels  
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44 and slopes was observed. The number of nursing handovers sent within 24h post-discharge was  
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46 92.8% pre-intervention and 93.1% post-intervention and no significant difference was observed  
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48 between levels and slopes. The results are presented in Figure 2 and the parameters estimates are  
49  
50 summarized in Table 2.  
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### *Length of hospital stay and unplanned readmission rates*

No significant decline in the levels and slopes between the pre-, and post-intervention was found with regard to LOS ( $\beta$  0.08, 95% CI -0.12 to 0.29  $p=0.45$ ) and unplanned readmission rates ( $\beta$  1.11, 95% CI -2.55 to 0.33  $p=0.17$ ). Median (IQR) LOS was 8.17 (4.75-15.13) and 8.56 (4.88-15.91) days and readmissions rates were as high as 11.1% and 12.3% pre-intervention and post-intervention, respectively.

### *Subgroup analysis*

In subgroup 1 (>30 feedback points), an absolute effect of 13.3% more medical handovers sent within 24h post-discharge was observed but this did not result in significant changes in level or slope (Figure 3). A reduction of 5.6 days in the median time between discharge and handovers with a significant change in level directly after the intervention was observed in subgroup 1 ( $\beta$  -5.29, 95% CI -8.70 to 1.87  $p=0.02$ ). Pre-intervention, group 2 (20-30 feedback points) had the highest rate of medical handovers sent within 24h and the lowest median time between discharge and medical handovers but no intervention effect was. Both pre- and post-intervention, subgroup 3 (<10 points) had the lowest rates of medical handovers sent within 24h, and the highest median time. No intervention effect was observed in subgroup 3.

### **Discussion**

In the total study population, a structured discharge bundle, the Transfer Intervention Procedure (TIP), did not lead to improved timeliness of patient handovers. Although medical handovers were sent faster post-intervention (pre-intervention median 6.15; post-intervention 4.08 days), we were unable to show significant differences in level and slopes, both with regard to the median time and the number of medical handovers sent within 24h. However, large inter-hospital variation was observed and a significant intervention effect on the median time between discharge and medical

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3 handovers was seen in those hospitals with relatively high protocol adherence and attention for  
4 implementation. Rates of nursing handovers sent within 24h were both pre- and post-intervention  
5 above 90%. No intervention effect was found for length of hospital stay (LOS) and readmissions.  
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8  
9 Extensive research has been conducted to improve patient handovers from hospital to home<sup>7</sup>  
10  
11 <sup>16</sup>. Summarizing findings of earlier discharge interventions that aimed to improve coordination of  
12 care and communication between hospital and primary care providers, Hesselink et al.,<sup>7</sup> and  
13 Kripalani et al.,<sup>8</sup> showed that some studies were able to improve timeliness of discharge summaries.  
14 These interventions, however, were based on the introduction of fax, email or web-based transfers  
15 of information, which is increasingly becoming standard practice in Dutch hospitals. Yet, further  
16 improvement may lie in electronic sending systems that support the use of standardized formats that  
17 pull information from patient files into discharge letters or that send discharge summaries  
18 automatically.  
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28 While the observed median time between discharge and sending medical handovers at our  
29 first pre-intervention measurement point was consistent with a recent Dutch study,<sup>14</sup> a trend  
30 towards sending handovers faster was observed along the pre-intervention period. During this  
31 period, no interventions were implemented but attention was already brought to the discharge  
32 procedure, e.g. by establishing project groups and the kick-off meeting. Since education on the  
33 importance of the intervention is an important aspect of implementation,<sup>13 31</sup> this could explain why  
34 improvements were already observed.  
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43 Although positive trends in the pre-intervention period were less pronounced in the  
44 subgroup analysis, results of the separate analyses support the idea that attention is important.  
45 Whereas a significant reduction of six days in the median time between discharge and medical  
46 handovers was observed in hospitals that paid much attention to implementation, no intervention  
47 effect was observed in hospitals that paid moderate to nearly no attention. It should be noted that  
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3 the hospitals that paid moderate attention had relatively good pre-intervention scores. A smaller  
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5 window for improvement in these hospitals might also explain a lack of intervention effect<sup>32</sup>.

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7 Implementation of the TIP procedure did not reveal a reduction of LOS. Although a possible  
8  
9 explanation can be low overall compliance with our study protocol, it is also probable that over the  
10  
11 past years, average LOS has decreased to a minimum<sup>33</sup>. Given current pressure on availability of  
12  
13 hospital beds, patients are discharged as soon as possible. This may account for inadequate discharge  
14  
15 processes, since physicians are forced to prioritize acute health care over discharge-related tasks<sup>34 35</sup>.

16  
17 Given increasingly shorter LOS<sup>33</sup> and the often complex care needs patient face, patient  
18  
19 preparation should be an important aspect of the discharge process. In fact, the most effective  
20  
21 discharge interventions seem to have educational components<sup>36</sup>. Unfortunately, given the workload  
22  
23 among residents, implementation of a personalized patient discharge letter was unsuccessful. E.g.,  
24  
25 posing the question “do you feel ready to go home”<sup>37</sup> or post-discharge telephone contact,<sup>7</sup> might be  
26  
27 less time-consuming ways to involve patients. However, to prevent readmissions more effort might  
28  
29 be necessary. Previous interventions that revealed a reduction in readmission rates, consist of  
30  
31 individualized discharge planning or continue post-discharge<sup>16 38</sup>. However, we believe that a  
32  
33 structured discharge process such as the TIP should form the basis for a safe handover for every  
34  
35 patient (Figure 1).  
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#### 41 *Implications for further research*

42  
43 Our study sheds light on the difficulties that come along with implementation of a discharge bundle.  
44  
45 A comprehensive exploration of local barriers for each step in the TIP discharge procedure might be  
46  
47 helpful in order to develop tailor made interventions on a local or department level<sup>39</sup>. However,  
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49 given the positive pre-intervention trends and significant reduction in the median time between  
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51 discharge and medical handovers in hospitals that paid much attention to implementation, further  
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3 improvement of the discharge process may lie in interventions that create more awareness of the  
4 importance of timely handovers and continuity of care<sup>35</sup>.  
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### 8 9 *Strengths and limitations*

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11 The design of the study was a strength of the study. A before-after design would probably have led to  
12 a significant intervention-effect, and ITS analysis provided valuable information on pre-intervention  
13 trends. Our study has some limitations. We only recorded the date of sending patient handovers.  
14  
15 Knowing whether they were received by GPs would also have provided valuable information.  
16  
17 Besides, we did not look at the content of handovers, while this might have given us important  
18 insights. This also accounts for medication handovers, particularly since medication changes are  
19 often missing<sup>14</sup>. Further, information on timeliness and accurateness of medication handovers sent  
20 to pharmacists would have been informative but these were mostly sent by fax and these data could  
21 not be collected from patient records. Lastly, it was not possible to evaluate percentages of protocol  
22 adherence and the process evaluation with the project leaders might have been an overestimation.  
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24 However, the process evaluation was in line with the efforts observed during implementation.  
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### 36 **Conclusion**

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38 Implementation of a structured discharge bundle, the Transfer Intervention Procedure (TIP), did not  
39 lead to more patient handovers sent within 24h post-discharge. Large inter-hospital variation was  
40 observed however, and a significant intervention effect on the median time between discharge and  
41 medical handovers was seen in those hospitals that brought much attention to implementation. We  
42 believe that future interventions should continue to create awareness of the importance of timely  
43 handovers and we hope that our study contributes to this, stimulating hospitals to further structure  
44 and improve their discharge process.  
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3 *Contributors:* BB, SG, and RVS designed the study. BB and SG, conceived the study and obtained  
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38 *Data sharing statement:* No additional data are available.  
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**Table 1.** Baseline characteristics

Variable	Overall (N=2091)	Pre-intervention (N=1039)	Post-intervention (N=1052)
<b>Age in years, mean (SD)<sup>a</sup></b>	68.07 (16.57)	67.66 (16.70)	68.48 (16.45)
<b>Male, No. (%)</b>	971 (46.4)	493 (47.4)	478 (45.4)
<b>Living arrangements before admission, No. (%)</b>			
Independent	1814 (86.7)	883 (84.9)	931 (88.5)
Nursing home	49 (2.3)	27 (2.6)	22 (2.1)
Senior residence/Assisted living	168 (8.1)	91 (8.8)	77 (7.3)
Missing	60 (2.9)	38 (3.7)	22 (2.1)
<b>Marital status, No. (%)</b>			
Married or living together	1125 (53.8)	556 (53.5)	569 (54.1)
Single or divorced	456 (21.8)	212 (20.4)	244 (23.2)
Widow/widower	435 (20.8)	224 (21.6)	211 (20.1)
Missing	75 (3.6)	47 (4.5)	28 (2.7)
<b>Charlson Comorbidity Index<sup>b</sup> (mean, SD<sup>a</sup>)</b>	2.05 (2.05)	2.10 (2.08)	2.01 (2.03)
<b>Polypharmacy, No. (%)<sup>c,d,e</sup></b>	1247 (59.6)	586 (56.4)	661 (62.8)
Missing	12 (.6)	8 (.8)	4 (.4)
<b>Hospitalization in past 6 months, No. (%)</b>	705 (33.7)	339 (32.6)	336 (34.8)
<b>Acute hospitalization, No. (%)<sup>c,f</sup></b>	73.0 (73.0)	725 (69.8)	801 (76.1)
<b>Admission ward, internal medicine No. (%)</b>	1051 (50.3)	524 (50.4)	527 (50.1)
<b>Discharge destination, No. (%)</b>			
Home	1551 (74.2)	770 (74.1)	781 (74.2)
Other health care setting, of which	482 (23.1)	238 (23.0)	244 (23.2)
Rehabilitation center	268 (12.8)	120 (11.5)	148 (14.1)
Nursing home	158 (7.6)	80 (7.7)	78 (7.4)
Assisted living	34 (1.6)	26 (2.5)	8 (0.8)
Other hospital	22 (1.1)	12 (1.2)	10 (1.0)
Missing	58 (2.8)	31 (3.0)	27 (2.6)

<sup>a</sup> Standard Deviation, <sup>b</sup> Range of 0 to 31, with a higher score indicating more or more severe comorbidity<sup>30</sup>, <sup>c</sup> Use of 5 or more different medications, <sup>d</sup> Chi-Square, <sup>e</sup> P-value = 0.004, <sup>f</sup> P-value = 0.001

**Table 2.** Interrupted time series analysis; medical and nursing handovers

	<i>Medical handovers &lt;24 hrs after discharge (%)<sup>a</sup></i>			<i>Time between discharge and medical letter (days)<sup>b</sup></i>			<i>Nursing handovers &lt;24 hrs after discharge (%)<sup>a</sup></i>		
	$\beta$ (SE)	95% CI	p-value	$\beta$ (SE)	95% CI	p-value	$\beta$ (SE)	95% CI	p-value
Intercept	17.51 (3.79)	10.08 to 24.93	<0.01	7.20 (0.29)	6.63 to 7.76	<0.01	91.85 (2.71)	86.53 to 97.16	<0.01
Trend pre-intervention ( $\beta_1$ )	1.49 (0.97)	-0.42 to 3.40	0.16	-0.30 (0.07)	-0.45 to - 0.16	<0.01	0.28 (0.70)	-1.09 to 1.64	0.70
Level change directly after intervention ( $\beta_2$ )	6.43 (10.13)	-13.43 to 26.28	0.54	-0.62 (0.74)	-2.07 to 0.84	0.43	6.32 (7.25)	-7.89 to 20.53	0.41
Trend differences ( $\beta_3$ )	-0.94 (1.38)	-3.64 to 1.75	0.51	0.05 (0.10)	-0.14 to 0.25	0.61	-0.81 (0.99)	-2.74 to 1.12	0.43
	Absolute effect directly after intervention: -0.17%			Absolute effect directly after intervention: -0.25 days			Absolute effect directly after intervention: 0.62%		

$\beta_1$  estimates the pre-intervention slope.

$\beta_2$  estimates the difference between the observed level just after the intervention started and that predicted by the pre-intervention slope.

$\beta_3$  estimates the difference in trend/slopes between the pre-intervention and post-intervention period.

SE: Standard Error, CI: Confidence Interval

**Figure 1. Pyramid for post-discharge care**

A structured discharge process such as the TIP procedure should form the basis for every patient. For patients discharged with post-discharge care (20-25%), nursing handovers should be set up within 48h after admission and be sent within 24h post-discharge. Complex patients with a high readmission risk (10%) require a (nurse) case manager or transitional care in the transition from hospital to home. Adapted from van Seben et al.<sup>40</sup>

**Figure 2.**

**Panel A** The number of medical handovers sent within 24 hours.

**Panel B** median time in days between discharge and the medical handovers.

**Figure 3. Hospital differences based on implementation score.**

The inter-hospital differences in rates of medical discharge letters being sent within 24h in the pre- and post-intervention based on the extent of implementation and used implementation strategies. Group 1 received >30 feedback implementation points, group 2 received 20-30 implementation points, group 3 received <20 points.

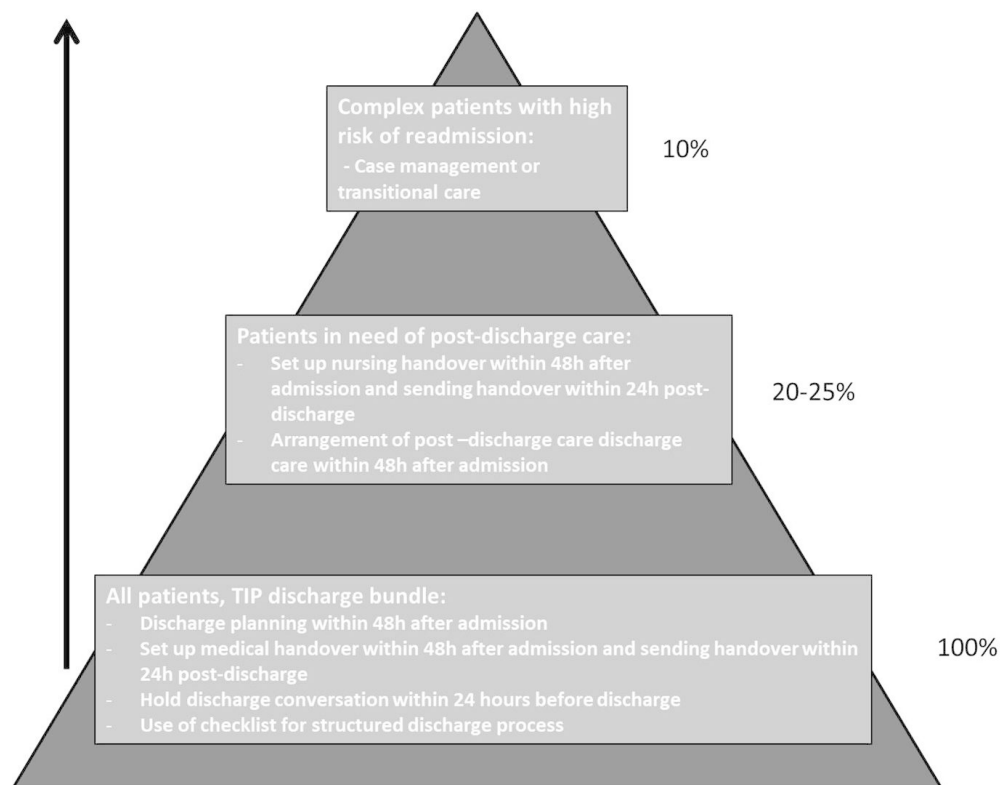


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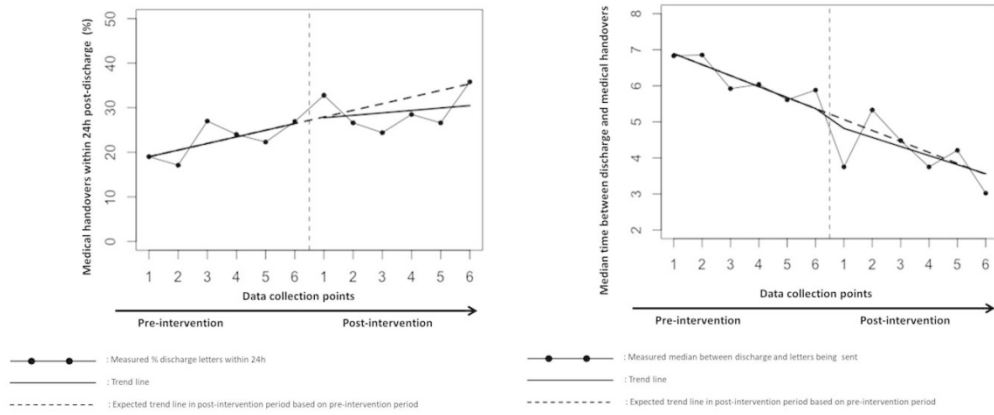


Figure 2.  
Panel A The number of medical handovers sent within 24 hours.  
Panel B median time in days between discharge and the medical handovers.

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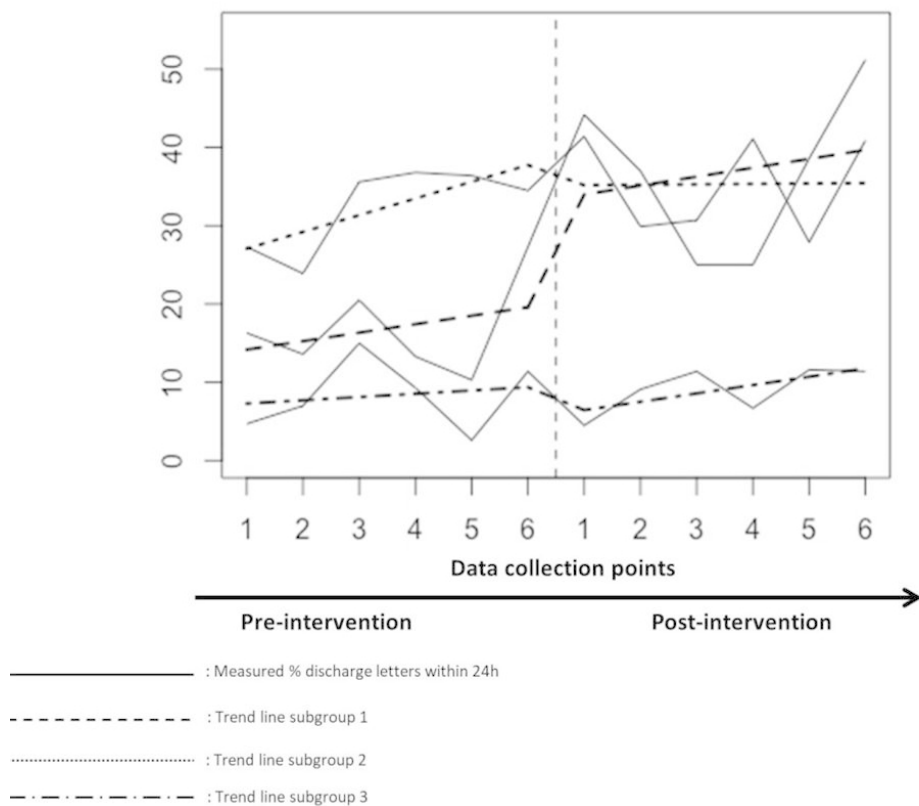


Figure 3. Hospital differences based on implementation score. The inter-hospital differences in rates of medical discharge letters being sent within 24h in the pre- and post-intervention based on the extent of implementation and used implementation strategies. Group 1 received >30 feedback implementation points, group 2 received 20-30 implementation points, group 3 received <20 points.

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**Supplement Table 1.** Adherence to the Intervention Protocol

	Hospital 1	Hospital 2	Hospital 3	Hospital 4	Hospital 5	Hospital 6	Hospital 7	Hospital 8
Pre-intervention	Sep '15 - Feb '16	Oct '15 - March '16	Jan '16 - June '16	Dec '15 - May '16	March '16 – Aug '16	April '16 – Sep '16	May '16 – Oct '16	April '16 – Sep '16
Implementation	March '16 - April '16	April '16 - May '16	July '16 - Aug '16	June '16 - July '16	Sep '16 - Oct '16	Oct '16 - Nov '16	Nov '16 - Dec '16	Oct '16 - Nov '16
Post-intervention	May '16 – Oct '16	June '16 - Nov '16	Sep '16 – Feb '17	Aug '16 - Jan '16	Nov '16 – April '17	Dec '16 – May '17	Jan '17 – June '17	Dec '16 – May '17
<b>Leadership and education of project leaders</b>								
Who were present at the kick off meeting February, 2016?	Hospital president; local project leader; 2 team leaders (nurses); 2 physicians; nurse; pharmacists	Local project leader; geriatrician; head of the liaison department; physician	2 local project leaders; head of the liaison department	Chief of staff; local project leader; team leader surgery ward (nurse); head of the liaison department	Local project leader; head of the liaison department; manager patient logistics; 2 team leaders (nurses)	2 local project leaders	Local project leader	Local project leader; senior researcher transitional care; medical specialist,
Who were present at the first feedback session?	Project leader; head of the liaison department	Project leader; pharmacist; communication assistant	2 local project leaders; liaison nurse	Project leader; liaison nurse; nurse geriatrics	local project leader	2 local project leaders	-	2 project leaders
Who were present at the second feedback session?	Project leader	Project leader	2 project leaders	-	Project leader	-	Project leader	2 project leaders
<i>Implementation points</i>	10	8	8	7	7	4	2	7
<b>Project group</b>								
Was there a local TIP project group, and who participated?	Yes, project leader; 2 senior nurses of participating wards, management assistant	Yes, project leader; geriatrician; head liaison department, physician; pharmacist; communication assistant; manager Security & Services	Yes, 2 project leaders; 2 residents; 2 medical specialists; nurse; liaison nurse; pharmacist; manager	Yes, chief of staff; project leader; 2 team leaders (nurses); head liaison department; orthopedist	Yes, project leader; head liaison department; 2 medical specialists, geriatrician	No	No	Yes, local project leader; 3 medical specialists; 2 residents, manager quality and safety; manager process optimization; medical director
How often did the local project group meet? 1 point per meeting	Monthly for 2 months, during pilot period every week (2 months).	Every five weeks during pre-intervention and pilot period	2 times, before pilot period.	Every two weeks during pre-intervention period	Every six weeks, during pre-intervention and pilot period	-	-	Monthly during pre-intervention, pilot period and first two months of post-

								intervention period
<i>Implementation points</i>	10	12	10	18	10	0	0	17
<b>Implementation of TIP elements</b>								
Was it policy to set a discharge date within 48h after admission?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Was the planned discharge date communicated to patients?	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Was it policy to start with arrangement of required post-discharge care within 48h after admission?	No, liaison nurse has to wait for final discharge date	No, liaison nurse has to wait for final discharge date	Yes	Yes	No, liaison department is overloaded	Yes	No, liaison nurse has to wait for final discharge date	Yes
Was it policy to set up patient handovers within 48h after admission?	No	No	No	No	No	No	No	No
Did physicians hold discharge conversations, using a checklist during the pilot period?	No	No	No	No	No	No	No	No
Does the nurse holds a discharge conversation, using a checklist?	Yes	No	Yes	Yes	Yes	No	Yes	Yes
Was the patient discharge letter implemented?	Yes, but only for some diagnosis at internal medicine ward.	No	No	No	No	Yes, but only at internal medicine ward for frail older patients.	No	No, a discharge summary was implemented instead.
<i>Implementation points</i>	3.5	2	4	4	3	2.5	3	4.5
<b>Education of physicians and nurses</b>								

How were physicians and nurses informed about the TIP and how often?	Kick-off meeting at participating wards; during morning report; working instructions were sent by email to all physicians	Kick-off meeting; meeting at participating wards; E-learning; 1 feedback meeting	During morning reports; project leader informed every physician separately; intranet; email	During morning reports; intranet; email; posters & pocket cards; and project leaders went to participating wards to inform physicians and nurses	Email and project leader went to participating wards	Kick-off meeting, during several morning reports	Physicians were not educated with regard to the intervention	During several morning report; email; project leaders went to participating wards to inform physicians and nurses; medical specialists from project group informed physicians in person									
Did physicians and/or nurses receive feedback with regard to their discharge letters and if yes, how often?	No.	No	No	No	No	Only for nurses	No	Yes, daily on internal medicine and monthly on surgery ward, via email.									
<i>Implementation points</i>	3	4	4	5	2	2.5	0	5									
<b>Total implementation points</b>	<b>26.5</b>	<b>26</b>	<b>26</b>	<b>34</b>	<b>22</b>	<b>9</b>	<b>5</b>	<b>33.5</b>									
<b>Pre-intervention vs. post-intervention period scores</b>																	
<b>Pre-intervention period</b>																	
median	% letters within 24h	8.15	9.0	0.90	47.3	6.71	23.5	10.48	13.1	0.79	50.0	6.79	9.2	14.21	7.6	5.83	20.9
<b>Post-intervention</b>																	
median	% letters within 24h	9.08	19.5	1.0	48.5	5.48	24.2	5.79	19.7	0.29	49.6	7.98	16.7	22.44	1.5	0.83	53.8

**Revised Standards for Quality Improvement Reporting Excellence (SQUIRE 2.0)  
September 15, 2015**

Text Section and Item Name	Section or Item Description
<b>Notes to authors</b>	<ul style="list-style-type: none"> <li>• The SQUIRE guidelines provide a framework for reporting new knowledge about how to improve healthcare</li> <li>• The SQUIRE guidelines are intended for reports that describe <a href="#">system</a> level work to improve the quality, safety, and value of healthcare, and used methods to establish that observed outcomes were due to the <a href="#">intervention(s)</a>.</li> <li>• A range of approaches exists for improving healthcare. SQUIRE may be adapted for reporting any of these.</li> <li>• Authors should consider every SQUIRE item, but it may be inappropriate or unnecessary to include every SQUIRE element in a particular manuscript.</li> <li>• The SQUIRE Glossary contains definitions of many of the key words in SQUIRE.</li> <li>• The Explanation and Elaboration document provides specific examples of well-written SQUIRE items, and an in-depth explanation of each item.</li> <li>• Please cite SQUIRE when it is used to write a manuscript.</li> </ul>
<b>Title and Abstract</b>	
<b>1. Title</b>	Indicate that the manuscript concerns an <a href="#">initiative</a> to improve healthcare (broadly defined to include the quality, safety, effectiveness, patient-centeredness, timeliness, cost, efficiency, and equity of healthcare)
<b>2. Abstract</b>	<ol style="list-style-type: none"> <li>a. Provide adequate information to aid in searching and indexing</li> <li>b. Summarize all key information from various sections of the text using the abstract format of the intended publication or a structured summary such as: background, local <a href="#">problem</a>, methods, interventions, results, conclusions</li> </ol>
<b>Introduction</b>	<i>Why did you start?</i>
<b>3. <a href="#">Problem Description</a></b>	Nature and significance of the local <a href="#">problem</a>
<b>4. Available knowledge</b>	Summary of what is currently known about the <a href="#">problem</a> , including relevant previous studies

5. <b><u>Rationale</u></b>	Informal or formal frameworks, models, concepts, and/or <a href="#">theories</a> used to explain the <a href="#">problem</a> , any reasons or <a href="#">assumptions</a> that were used to develop the <a href="#">intervention(s)</a> , and reasons why the <a href="#">intervention(s)</a> was expected to work
6. <b>Specific aims</b>	Purpose of the project and of this report
<b>Methods</b>	<i>What did you do?</i>
7. <b><u>Context</u></b>	Contextual elements considered important at the outset of introducing the <a href="#">intervention(s)</a>
8. <b><u>Intervention(s)</u></b>	<ol style="list-style-type: none"> <li>Description of the <a href="#">intervention(s)</a> in sufficient detail that others could reproduce it</li> <li>Specifics of the team involved in the work</li> </ol>
9. <b>Study of the Intervention(s)</b>	<ol style="list-style-type: none"> <li>Approach chosen for assessing the impact of the <a href="#">intervention(s)</a></li> <li>Approach used to establish whether the observed outcomes were due to the <a href="#">intervention(s)</a></li> </ol>
10. <b>Measures</b>	<ol style="list-style-type: none"> <li>Measures chosen for studying <a href="#">processes</a> and outcomes of the <a href="#">intervention(s)</a>, including rationale for choosing them, their operational definitions, and their validity and reliability</li> <li>Description of the approach to the ongoing assessment of contextual elements that contributed to the success, failure, efficiency, and cost</li> <li>Methods employed for assessing completeness and accuracy of data</li> </ol>
11. <b>Analysis</b>	<ol style="list-style-type: none"> <li>Qualitative and quantitative methods used to draw <a href="#">inferences</a> from the data</li> <li>Methods for understanding variation within the data, including the effects of time as a variable</li> </ol>
12. <b>Ethical Considerations</b>	<a href="#">Ethical aspects</a> of implementing and studying the <a href="#">intervention(s)</a> and how they were addressed, including, but not limited to, formal ethics review and potential conflict(s) of interest
<b>Results</b>	<i>What did you find?</i>
13. <b>Results</b>	<ol style="list-style-type: none"> <li>Initial steps of the <a href="#">intervention(s)</a> and their evolution over time (e.g., time-line diagram, flow chart, or table), including modifications made to the intervention during the project</li> <li>Details of the <a href="#">process</a> measures and outcome</li> <li>Contextual elements that interacted with the <a href="#">intervention(s)</a></li> <li>Observed associations between outcomes, interventions, and relevant contextual elements</li> <li>Unintended consequences such as unexpected benefits, problems, failures, or costs associated with the <a href="#">intervention(s)</a>.</li> <li>Details about missing data</li> </ol>
<b>Discussion</b>	<i>What does it mean?</i>
14. <b>Summary</b>	<ol style="list-style-type: none"> <li>Key findings, including relevance to the <a href="#">rationale</a> and specific aims</li> <li>Particular strengths of the project</li> </ol>

<p><b>15. Interpretation</b></p>	<p>a. Nature of the association between the <a href="#">intervention(s)</a> and the outcomes</p> <p>b. Comparison of results with findings from other publications</p> <p>c. Impact of the project on people and <a href="#">systems</a></p> <p>d. Reasons for any differences between observed and anticipated outcomes, including the influence of <a href="#">context</a></p> <p>e. Costs and strategic trade-offs, including <a href="#">opportunity costs</a></p>
<p><b>16. Limitations</b></p>	<p>a. Limits to the <a href="#">generalizability</a> of the work</p> <p>b. Factors that might have limited <a href="#">internal validity</a> such as confounding, bias, or imprecision in the design, methods, measurement, or analysis</p> <p>c. Efforts made to minimize and adjust for limitations</p>
<p><b>17. Conclusions</b></p>	<p>a. Usefulness of the work</p> <p>b. Sustainability</p> <p>c. Potential for spread to other <a href="#">contexts</a></p> <p>d. Implications for practice and for further study in the field</p> <p>e. Suggested next steps</p>
<p><b>Other information</b></p>	
<p><b>18. Funding</b></p>	<p>Sources of funding that supported this work. Role, if any, of the funding organization in the design, implementation, interpretation, and reporting</p>



**Table 2. Glossary of key terms used in SQUIRE 2.0. This Glossary provides the intended meaning of selected words and phrases as they are used in the SQUIRE 2.0 Guidelines. They may, and often do, have different meanings in other disciplines, situations, and settings.**

### **Assumptions**

Reasons for choosing the activities and tools used to bring about changes in healthcare services at the [system](#) level.

### **Context**

Physical and sociocultural makeup of the local environment (for example, external environmental factors, organizational dynamics, collaboration, resources, leadership, and the like), and the interpretation of these factors (“sense-making”) by the healthcare delivery professionals, patients, and caregivers that can affect the effectiveness and [generalizability](#) of [intervention\(s\)](#).

### **Ethical aspects**

The value of [system](#)-level [initiatives](#) relative to their potential for harm, burden, and cost to the stakeholders. Potential harms particularly associated with efforts to improve the quality, safety, and value of healthcare services include [opportunity costs](#), invasion of privacy, and staff distress resulting from disclosure of poor performance.

### **Generalizability**

The likelihood that the [intervention\(s\)](#) in a particular report would produce similar results in other settings, situations, or environments (also referred to as external validity).

### **Healthcare improvement**

Any systematic effort intended to raise the quality, safety, and value of healthcare services, usually done at the [system](#) level. We encourage the use of this phrase rather than “quality improvement,” which often refers to more narrowly defined approaches.

### **Inferences**

The meaning of findings or data, as interpreted by the stakeholders in healthcare services – improvers, healthcare delivery professionals, and/or patients and families

### **Initiative**

A broad term that can refer to organization-wide programs, narrowly focused projects, or the details of specific interventions (for example, planning, execution, and assessment)

### **Internal validity**

Demonstrable, credible evidence for efficacy (meaningful impact or change) resulting from introduction of a specific intervention into a particular healthcare [system](#).

### **Intervention(s)**

The specific activities and tools introduced into a healthcare [system](#) with the aim of changing its performance for the better. Complete description of an intervention includes its inputs, internal activities, and outputs (in the form of a logic model, for example), and the mechanism(s) by which these components are expected to produce changes in a [system's](#) performance.

### **Opportunity costs**

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2  
3 Loss of the ability to perform other tasks or meet other responsibilities resulting from the diversion  
4 of resources needed to introduce, test, or sustain a particular [improvement](#) initiative  
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### 7 **Problem**

8 Meaningful disruption, failure, inadequacy, distress, confusion or other dysfunction in a healthcare  
9 service delivery [system](#) that adversely affects patients, staff, or the [system](#) as a whole, or that  
10 prevents care from reaching its full potential  
11

### 12 **Process**

13 The routines and other activities through which healthcare services are delivered  
14  
15

### 16 **Rationale**

17 Explanation of why particular [intervention\(s\)](#) were chosen and why it was expected to work, be  
18 sustainable, and be replicable elsewhere.  
19

### 20 **Systems**

21 The interrelated structures, people, [processes](#), and activities that together create healthcare services  
22 for and with individual patients and populations. For example, systems exist from the personal self-  
23 care system of a patient, to the individual provider-patient dyad system, to the microsystem, to the  
24 macrosystem, and all the way to the market/social/insurance system. These levels are nested within  
25 each other.  
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### 28 **Theory or theories**

29 Any “reason-giving” account that asserts causal relationships between variables (causal theory) or  
30 that makes sense of an otherwise obscure [process](#) or situation (explanatory theory). Theories come  
31 in many forms, and serve different purposes in the phases of [improvement](#) work. It is important to  
32 be explicit and well-founded about any informal and formal theory (or theories) that are used.  
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# BMJ Open

## A safe handover for every patient: an interrupted time series analysis to test the effect of a structured discharge bundle

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<b>Primary Subject Heading</b>:	Health services research
Secondary Subject Heading:	Communication, Health services research
Keywords:	Discharge Bundle, Patient Handovers, Discharge Letter, Patient Safety, Interrupted Time Series, Quality Improvement

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Manuscripts

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3 **A safe handover for every patient: an interrupted time series analysis to test the effect of a**  
4 **structured discharge bundle**  
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40 Jolanda Maaskant, Rosanne van Seben, Suzanne Geerlings and Bianca Buurman  
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44 *Key words:* Discharge Bundle, Patient Handovers, Patient Safety, Interrupted Time Series, Quality  
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50 Word count: 3214  
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## Abstract

**Objective** Patient handovers are often delayed, patients are hardly involved in their discharge process and hospital-wide standardized discharge procedures are lacking. The aim of this study was to implement a structured discharge bundle and to test the effect on timeliness of medical and nursing handovers.

**Design** Interrupted time series with six pre-intervention and six post-intervention data collection points (September 2015 through June 2017).

**Setting** Internal medicine and surgical wards.

**Participants** Patients ( $\geq 18$  years) admitted for more than 48h to surgical or internal medicine wards.

**Intervention** The Transfer Intervention Procedure (TIP), containing four elements: planning the discharge date within 48h post-admission, arrangements for post-discharge care, preparing handovers and personalized patient discharge letter; and a discharge conversation 12-24h before discharge.

**Outcome measures** The number of medical and nursing handovers sent within 24h. Secondary outcomes were median time between discharge and medical handovers, length of hospital stay (LOS) and unplanned readmissions.

**Results** Pre-intervention 1039 and post-intervention 1052 patient records were reviewed. No significant change in levels and slopes was observed in the number of medical and nursing handovers sent within 24h. The median (interquartile range) time between discharge and medical handovers decreased from 6.15 (0.96-15.96) to 4.08 (0.33-13.67) days, but no significant difference in levels and slopes was found. No intervention-effect was observed for LOS and readmission. In subgroup analyses, a reduction of 5.6 days in the median time between discharge and medical handovers was observed in hospitals with high protocol adherence and much attention for implementation.

**Conclusion** Implementation of a structured discharge bundle did not lead to improved timeliness of patient handovers. However, large inter-hospital variation was observed and an intervention effect

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3 on the median time between discharge and medical handovers was seen in hospitals with high  
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5 protocol adherence. Future interventions should continue to create awareness of the importance of  
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7 timely handovers.  
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11 **Trial Registration:** Dutch Trial Registry: NTR5951  
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#### 14 15 **Strengths and limitations of this study**

- 16  
17 • This study aimed to implement a structured discharge bundle to improve patient handovers  
18  
19 for every patient.
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21 • The study design, i.e. Interrupted Time Series Analysis, provided valuable information on pre-  
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23 intervention trends, which strengthens the results.
- 24  
25 • Sensitivity analysis provided important insight into the inter-hospital variation and  
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27 differences in intervention effects among hospitals.
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29 • Only the date of sending patient handovers were recorded. Knowing whether the next care  
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31 provider received information would have been informative.
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33 • It was not possible to evaluate percentages of compliance with the study protocol.  
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35 Therefore, the process evaluation with the project leaders might have been an  
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37 overestimation.  
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## Introduction

As hospital stays have become shorter and full recovery often takes place at home,<sup>1</sup> a safe transition from hospital to home or nursing home has become more and more important. Besides, a rising number of older chronically ill patients who move within the health care system, requires continuity of care<sup>2,3</sup>. However, transitions from hospital to primary care settings are still considered a high-risk process. Patients are discharged with little coordination or follow-up and are hardly involved in their own discharge process<sup>4,5</sup>.

Inadequate transitions may have serious implications for patient safety and quality of care. Post-discharge adverse events such as medication errors, can be the consequence of insufficient or lacking communication between hospital and primary care providers, thereby contributing to higher resource use and unplanned readmission rates<sup>6-11</sup>. In fact, unplanned readmission rates in the first month post-discharge are as high as 20%<sup>12</sup> and a recent study shows that half of them are deemed preventable<sup>11</sup>.

The root of a safe transition from hospital to home or nursing home is a timely transfer of the medical handover, that is a letter containing accurate medical discharge information for the next care provider<sup>8,13</sup>. The general practitioner (GP) can only take over responsibility for a patient safely, when receiving a medical handover containing accurate information on, e.g., medications, and follow-up<sup>13</sup>. Nonetheless, a review of Kripalani et al. showed that medical handover are often not available, lack important information or are not sent in a timely manner<sup>8</sup>. Also, a more recent study performed in 20 Dutch hospitals showed that in 10% of cases medical handover were missing and the remainder was on average sent after one week,<sup>14</sup> even though unplanned readmissions most frequently occur within the first week post-discharge<sup>15</sup>.

Previous studies that aimed to improve patient handovers, mainly focused on specific high risk populations and targeted patient-related factors<sup>16-18</sup>. Although such interventions on individualized discharge planning or transitional care have been effective in reducing readmission<sup>16,17</sup>

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2 and post-discharge mortality rates,<sup>18-20</sup> organizational factors that form the basis of a safe handover  
3 should also be optimally arranged<sup>13 21</sup>. In fact, in order to ensure patient safety and continuity of care,  
4 early discharge planning, a structured discharge process and timely handovers might be essential<sup>13 21</sup>  
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and post-discharge mortality rates,<sup>18-20</sup> organizational factors that form the basis of a safe handover should also be optimally arranged<sup>13 21</sup>. In fact, in order to ensure patient safety and continuity of care, early discharge planning, a structured discharge process and timely handovers might be essential<sup>13 21</sup>. Besides, given that patients are often unprepared at time of discharge and uncertainties about aspects such as treatment or medication may exist,<sup>5</sup> patient education, e.g., in terms of a proper discharge conversation, should also be an important aspect of the discharge process<sup>6 7</sup>.

The aim of this study was, therefore, to implement a structured discharge process, the Transfer Intervention Procedure (TIP), in eight hospitals. The TIP contains four elements: planning the discharge date within 48h after admission, arrangements for required post-discharge care, preparing medical, medication, and nursing handovers and a personalized discharge letter for the patient (PPDL) within 48 hours after admission; and holding a discharge conversation 12 to 24h before discharge. We tested whether the TIP improved timeliness of medical and nursing handovers and investigated the effect of the TIP procedure on length of hospital stay and unplanned readmissions within 30-days post-discharge.

## Methods

### *Study design and setting*

We evaluated the implementation of the TIP discharge bundle in an interrupted time series (ITS), which is the strongest design when a randomized controlled trial is not feasible<sup>23 24</sup>. The trial protocol<sup>25</sup> was based on the recommendations for ITS studies,<sup>23</sup> and we adhered to the SQUIRE guidelines for quality improvement reporting<sup>26</sup>. The current study was part of a large national program, initiated by the Dutch Ministry of Health, Welfare, and Sport (abbreviated in Dutch: VWS): 'Addressing Waste in Health Care'. This program was set up in order to reduce inefficiencies in the provision of health care. As part of this program, a TIP study group was established, comprising a study coordinator, two supervisors, one clinical epidemiologist, a policy officer from the Ministry of



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3 VWS and local project leaders from the eight participating hospitals (one university and seven  
4 regional teaching throughout the Netherlands) that implemented the TIP bundle at one of their  
5 surgical and one of their internal medicine wards.  
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9 Outcomes before and after implementation of the TIP bundle were compared. Therefore, six  
10 pre-intervention measurements were conducted before implementation of the TIP and six post-  
11 intervention measurements after implementation. During the implementation period of two months  
12 no measurements were conducted. February 2016, a kick off meeting was held. Between March  
13 2016 and November 2016, hospitals started with implementation. Data collection started September  
14 2015 and ended June 2017 (Supplement Table 1). All patients (aged  $\geq 18$  years) admitted for more  
15 than 48h were eligible for inclusion. The Medical Ethics Research Committee (METC) confirmed that  
16 the Medical Research Involving Human Subjects Act did not apply to this research project and official  
17 approval was not required. Since the study involved a quality improvement intervention with  
18 negligible risk of harming patients, individual informed consent was waived for all participating  
19 hospitals. This trial was registered with the Dutch Trial Registry number NTR5951.  
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#### 34 *The discharge process in the Netherlands*

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36 In the Netherlands, primary care standards are relatively high and basically every person has a  
37 general practitioner (GP). When a person is hospitalized, responsibility is taken over from the GP by  
38 the medical specialist. After discharge, patient care becomes the responsibility of the GP again. It is  
39 policy for hospitals to provide patient handovers to the GP. However, there are no clear guidelines  
40 for hospitals how to arrange their discharge process. The Dutch healthcare inspectorate,<sup>27</sup> indicated  
41 that standardized discharge processes are lacking and errors that occur during handovers are often  
42 resolved informally.  
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51 After discharge from the hospital medical handovers, the hospital physician sends a medical  
52 handover to the primary care provider for every patient (e.g., nursing home physician or the GP).  
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3 Medical handovers include information on the reason for admission, diagnosis, comorbidity, the  
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5 course of admission, medical examinations, treatment, medication, the health status of the patient  
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7 at discharge, and instructions on follow-up<sup>28</sup>. Nursing handovers are only provided when the patient  
8  
9 is discharged to a nursing home or discharged home with post-discharge care at home. Nursing  
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11 handovers include information on the care provided during hospitalization, current nursing care  
12  
13 problems, the reason why (nursing) home care is initiated, and the intended outcomes of the care  
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15 that will be provided<sup>29</sup>.

### 19 *Intervention*

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22 Figure 1 (adapted from van Seben et al.<sup>30</sup>) illustrates how the TIP bundle forms the basis of a safe  
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24 handover from hospital to primary care for every patient, and if applicable, for patients discharged  
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26 with post-discharge care (e.g., home care or a nursing home) or for complex patients who require a  
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28 case manager or transitional care. As described in two previous studies,<sup>25 31</sup> the TIP bundle was  
29  
30 developed using input from focus group meetings with professionals, patient surveys and literature.  
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32 The TIP discharge bundle consists of four elements: 1) planning the discharge date within 48 hours  
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34 after admission and communication of the discharge date with the patient, 2) to start with  
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36 arrangements for required post-discharge care within 48 hours after admission; 3) to prepare patient  
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38 handovers (medical, medication, nurse) and personalized patient discharge letter (PPDL<sup>32</sup>) within 48  
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40 hours after admission, 4) to plan a discharge conversation with the patient to explain information  
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42 from the PPDL 12-24h before discharge. The PPDL is a standardized document, containing  
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44 understandable information for the patient on the reason for admission, hospital treatment, course  
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46 of the disease, possible sustained consequences or complications, and information on medication.  
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48 We constructed checklists based on the TIP, which served as remembering tool for nurses and  
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50 physicians in the electronic system or on pocket cards.  
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### *Patient and Public Involvement*

Our research question was developed from the perspective that patients are discharged with little coordination or follow-up and that they are often unprepared at time of discharge<sup>4 5</sup>. Patients were involved as participants in the construction of the TIP discharge bundle, which was based on, among others, patient satisfaction surveys<sup>25 31</sup>. Further, in a previous study in which the PPDL was developed and implemented, patient satisfaction with the PPDL was also assessed<sup>32</sup>.

### *Protocol adherence*

To enhance intervention fidelity and protocol adherence in the different hospitals, regular meetings were held with the TIP study group to report results and provide feedback, to discuss implementation, share experience and learn from each other's practices. A process evaluation was conducted with the project leaders to investigate protocol adherence, implementation strategies and attention paid to implementation. Elements that were considered included leadership and education of project leaders, projects group, extent of implementation of the discharge bundle, and education of physicians and nurses. Feedback points were awarded for all elements and for the extent to which the hospital complied to a certain element, e.g., for every person present at the kick off meeting or for every project meeting that was held. When a hospital partly complied to an element, e.g. automatically generated discharge summaries were provided to the patient instead of a PPDL or feedback on timely handovers was only provided to nurses, 0.5 feedback points were awarded. It was not possible to evaluate percentages of compliance with discharge conversations, planning discharge dates and arrangement of post-discharge care within 48h since these aspects were not reported in patient records. Hospital policies regarding these elements were assessed.

### *Outcome measures*

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3 Our primary outcome was the number of medical and nursing handovers sent within 24h. This time-  
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5 frame was based on a report of the Dutch healthcare inspectorate (In Dutch: Inspectie voor de  
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7 Gezondheidszorg en Jeugd (IGJ)) on the discharge process and handovers, in which it is stated that  
8  
9 accurate information needs to be available as quick as possible, but certainly within 24 hours for the  
10  
11 next care provider<sup>27</sup>. Medical handovers also include medication handovers and we considered the  
12  
13 time that these handovers were sent to the GP. The median time between discharge and the medical  
14  
15 handover was considered as secondary outcome. Further, secondary outcomes were length of  
16  
17 hospital stay (LOS) and rates of unplanned readmission within 30 days.  
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#### 21 *Baseline data collection*

22  
23 Data regarding patient characteristics included: demographics, admission ward and medical data (i.e.  
24  
25 presence of polypharmacy, comorbidity,<sup>33</sup> number of hospitalization in the six months prior to  
26  
27 current hospitalization). Variables were all collected from patient files. All data were reported and  
28  
29 analyzed anonymously.  
30  
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#### 34 *Sample size calculation*

35  
36 Based on the findings of a previous study<sup>31</sup> we expected to find a reduction of 78% in the time  
37  
38 between discharge and medical handovers sent. We conducted a power analysis with a number of  
39  
40 patients based on the number of hospital beds at the participating wards and feasibility with regards  
41  
42 to data collection, which was set at 11 patients. In a simulation study with 16 wards, each  
43  
44 contributing 65 patients, we estimated the power to be approximate 91% to demonstrate a  
45  
46 reduction of 78% in time until sending the medical handover, assuming that the intraclass correlation  
47  
48 coefficient does not exceed 0.05.  
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#### 53 *Statistical analysis*

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3 Descriptive characteristics of patients were calculated using proportions, means and standard  
4  
5 deviations (SD), or medians and interquartile ranges (IQR), as appropriate. Chi-squared analysis and  
6  
7 the Mann Whitney test were used to compare pre-intervention and post-intervention patient  
8  
9 characteristics. To analyze the intervention-effect, generalized least square analysis were performed  
10  
11 to assess changes in level and slope of the regression lines before and after implementation<sup>24</sup>. A  
12  
13 change in level is defined as the difference between the observed level at the first post-intervention  
14  
15 time point and that predicted by the pre-intervention time trend. A change in trend is defined as the  
16  
17 difference between post- and pre-intervention slopes. We explored models with no, a first order  
18  
19 autoregressive correlation between consecutive data collection periods, and longer autocorrelation  
20  
21 structures. We used the Akaike Information Criterion (AIC) as an estimator of the relative quality of a  
22  
23 model and we report the results from the best fitting model. Correction for baseline imbalances as  
24  
25 potential confounders led to results with similar estimates and identical interpretation. Based on the  
26  
27 extent of protocol adherence and the feedback points awarded, subgroup analyses were performed  
28  
29 to assess the intervention effect on the number of medical handovers within 24h and the median  
30  
31 time between discharge and medical handovers. Statistical analyses were performed using SPSS  
32  
33 Statistics ©, version 24.0, and Rstudio, version 1.0.136 (© 2009 – 2016 Rstudion, Inc).

## 38 **Results**

39  
40 A total of 2091 patient records (1039 pre- and 1052 post-intervention) were reviewed in order to  
41  
42 investigate the effect of the Transfer Intervention Procedure (TIP) on the timeliness of medical and  
43  
44 nursing handovers, length of hospital stay (LOS) and unplanned readmission within 30 days. Overall  
45  
46 patients had a mean age (SD) of 68.1 (16.6) and 46.4% were male (table 1). There were significant  
47  
48 differences between the pre-, and post-intervention group with regard to polypharmacy and the  
49  
50 ratio of acute/elective hospitalizations and these variables were considered as potential  
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3 confounders. However, correction for these potential confounders did not provide better models  
4  
5 than the presented models.  
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#### 8 9 *Protocol adherence*

10 Implementation strategies and protocol adherence are summarized in Supplement Table 1. Based on  
11  
12 the process evaluation, three subgroups were identified. Subgroup 1 (hospitals 4 and 8), >30  
13  
14 feedback points, paid considerable attention to implementation and there was relatively high  
15  
16 protocol adherence. In subgroup 2 (hospitals 1-3, and 5), 20-30 feedback points, there was relatively  
17  
18 high protocol adherence but moderate attention to implementation. In subgroup 3 (hospitals 6 and  
19  
20 7), <10 feedback points, nearly no attention was brought to implementation and there was low  
21  
22 compliance.  
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#### 28 29 *Medical and nursing handovers*

30 In the total study population, no intervention effect was found on the percentage of medical  
31  
32 handovers being sent within 24h after hospital discharge to the GP: 22.7% medical handovers were  
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34 sent within 24h pre-intervention, 29.1% post-intervention and no significant difference was observed  
35  
36 in the levels and slopes between the pre-intervention and post-intervention period. The median  
37  
38 (interquartile range, IQR) time between discharge and medical handovers decreased from 6.15 (0.96-  
39  
40 15.96) days, pre-intervention to 4.08 (0.33-13.67) days post-intervention. An absolute effect directly  
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42 after the implementation of the intervention of -0.25 days was found. We observed no significant  
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44 difference in the levels and slopes. The number of nursing handovers sent within 24h post-discharge  
45  
46 was 92.8% pre-intervention and 93.1% post-intervention and no significant difference was observed  
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48 between levels and slopes. The results are presented in Figure 2 and the parameters estimates are  
49  
50 summarized in Table 2.  
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### *Length of hospital stay and unplanned readmission rates*

No significant decline in the levels and slopes between the pre-, and post-intervention was found with regard to LOS ( $\beta$  0.08, 95% CI -0.12 to 0.29  $p=0.45$ ) and unplanned readmission rates ( $\beta$  1.11, 95% CI -2.55 to 0.33  $p=0.17$ ). Median (IQR) LOS was 8.17 (4.75-15.13) and 8.56 (4.88-15.91) days and readmissions rates were as high as 11.1% and 12.3% pre-intervention and post-intervention, respectively.

### *Subgroup analysis*

In subgroup 1 (>30 feedback points), an absolute effect of 13.3% more medical handovers sent within 24h post-discharge was observed but this did not result in significant changes in level or slope (Figure 3). A reduction of 5.6 days in the median time between discharge and handovers with a significant change in level directly after the intervention was observed in subgroup 1 ( $\beta$  -5.29, 95% CI -8.70 to 1.87  $p=0.02$ ). Pre-intervention, group 2 (20-30 feedback points) had the highest rate of medical handovers sent within 24h and the lowest median time between discharge and medical handovers but no intervention effect was observed. Both pre- and post-intervention, subgroup 3 (<10 points) had the lowest rates of medical handovers sent within 24h, and the highest median time. We observed no intervention effect in subgroup 3.

### **Discussion**

In the total study population, a structured discharge bundle, the Transfer Intervention Procedure (TIP), did not lead to improved timeliness of medical and nursing handovers. Although medical handovers were sent faster post-intervention (pre-intervention median 6.15; post-intervention 4.08 days), we were unable to show significant differences in level and slopes, both with regard to the median time and the number of medical handovers sent within 24h. However, large inter-hospital variation was observed and a significant intervention effect on the median time between discharge

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3 and medical handovers was seen in those hospitals with relatively high protocol adherence and  
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5 attention for implementation. Rates of nursing handovers sent within 24h were both pre- and post-  
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7 intervention above 90%. No intervention effect was found for length of hospital stay (LOS) and  
8  
9 readmissions.

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11 Extensive research has been conducted to improve patient handovers from hospital to home<sup>7</sup>  
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13 <sup>16</sup>. Summarizing findings of earlier discharge interventions that aimed to improve coordination of  
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15 care and communication between hospital and primary care providers, Hesselink et al.,<sup>7</sup> and  
16  
17 Kripalani et al.,<sup>8</sup> showed that some studies were able to improve timeliness of medical handovers.  
18  
19 These interventions, however, were based on the introduction of fax, email or web-based transfers  
20  
21 of information, which is increasingly becoming standard practice in Dutch hospitals. Yet, further  
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23 improvement may lie in electronic sending systems that support the use of standardized formats that  
24  
25 pull information from patient files into (medical) handovers or that send information to the next care  
26  
27 provider automatically.

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30 Although a before-after design would probably have led to a significant intervention-effect,  
31  
32 the ITS analysis provided valuable information on pre-intervention trends. The observed median time  
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34 between discharge and sending medical handovers at our first pre-intervention measurement point  
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36 was consistent with a recent Dutch study<sup>14</sup>, but a trend towards sending handovers faster was  
37  
38 already observed along the pre-intervention period. During the pre-intervention period, no  
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40 interventions were implemented and the TIP was introduced and implemented during a two-month  
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42 implementation period during which no measurements were conducted. However, in the pre-  
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44 intervention period, attention was already brought to the discharge process, e.g. by establishing  
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46 project groups and the kick-off meeting. Although these activities were not intended as  
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48 implementation strategies, in hindsight they might explain why improvements were already  
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50 observed during the pre-intervention period, particularly since education on the importance of the  
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52 intervention is an important aspect of implementation<sup>13 34 35</sup>.



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3 Although positive trends in the pre-intervention period were less pronounced in the  
4 subgroup analysis, results of the separate analyses support the idea that attention is important.  
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6 Whereas a significant reduction of six days in the median time between discharge and medical  
7 handovers was observed in hospitals that paid much attention to implementation, no intervention  
8 effect was observed in hospitals that paid moderate to nearly no attention. It should be noted that  
9 the hospitals that paid moderate attention had relatively good pre-intervention scores. A smaller  
10 window for improvement in these hospitals might also explain a lack of intervention effect<sup>36</sup>.  
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17 Implementation of the TIP procedure did not reveal a reduction of LOS. Although a possible  
18 explanation can be low overall compliance with our study protocol, it is also probable that over the  
19 past years, average LOS has decreased to a minimum<sup>37</sup>. Given current pressure on availability of  
20 hospital beds, patients are discharged as soon as possible. This may account for inadequate discharge  
21 processes, since physicians are forced to prioritize acute health care over discharge-related tasks<sup>38 39</sup>.  
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28 Given increasingly shorter LOS<sup>37</sup> and the often complex care needs patient face, patient  
29 preparation should be an important aspect of the discharge process. In fact, the most effective  
30 discharge interventions seem to have educational components<sup>40</sup>. Unfortunately, given the workload  
31 among residents, implementation of a personalized patient discharge letter was unsuccessful. E.g.,  
32 posing the question “do you feel ready to go home”<sup>41</sup> or post-discharge telephone contact,<sup>7</sup> might be  
33 less time-consuming ways to involve patients. However, to prevent readmissions more effort might  
34 be necessary. Previous interventions that revealed a reduction in readmission rates, consist of  
35 individualized discharge planning or continue post-discharge<sup>16 42</sup>. However, we believe that a  
36 structured discharge process such as the TIP should form the basis for a safe handover for every  
37 patient (Figure 1).  
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51 *Implications for further research*  
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3 Our study shed light on the difficulties that come along with implementation of quality improvement  
4 collaboratives<sup>43</sup>. Given the positive pre-intervention trends and significant reduction in the median  
5 time between discharge and medical handovers in hospitals that paid much attention to  
6 implementation, further improvements may lie in interventions that create more awareness of the  
7 importance of timely handovers and hospital physicians' crucial role in the provision of continuity of  
8 care. This might stimulate physicians' intrinsic motivation to provide a structured discharge process  
9 and thereby timely handovers<sup>739</sup>. Furthermore, we might also want to focus on local factors that lead  
10 to insufficient discharge processes. A comprehensive exploration of local barriers for each step in the  
11 TIP discharge process might be helpful in order to develop tailor made interventions on a local or  
12 department level to improve the discharge process<sup>44</sup>.

### 23 24 25 26 *Limitations*

27 Our study has some limitations. Firstly, we only recorded the date of sending medical handovers.  
28 Knowing whether they were received by GPs would also have provided valuable information.  
29 Secondly, we did not look at the content of handovers, while this might have given us important  
30 insights. Thirdly, medical staff was not blinded for the outcome measure, that is timely discharge  
31 letters. Knowing that timeliness of discharge letters was monitored might have altered our results.  
32 However, in most hospitals timeliness of discharge letters was already monitored before we started  
33 with our research project and the effect is likely to be minimal. Lastly, it was not possible to evaluate  
34 percentages of protocol adherence and the process evaluation with the project leaders might have  
35 been an overestimation. However, the process evaluation was in line with the efforts observed  
36 during implementation.

### 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 **Conclusion**

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3 Implementation of a structured discharge bundle, the Transfer Intervention Procedure (TIP), did not  
4 lead to more medical and nursing handovers sent within 24h post-discharge. Large inter-hospital  
5 variation was observed however, and a significant intervention effect on the median time between  
6 discharge and medical handovers was seen in those hospitals with high protocol adherence and that  
7 brought much attention to implementation. We believe that future interventions should continue to  
8 create awareness of the importance of timely handovers and we hope that our study contributes to  
9 this, stimulating hospitals to further structure and improve their discharge process.  
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47

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**Table 1.** Baseline characteristics

Variable	Overall (N=2091)	Pre- intervention (N=1039)	Post- intervention (N=1052)
<b>Age in years, mean (SD)<sup>a</sup></b>	68.07 (16.57)	67.66 (16.70)	68.48 (16.45)
<b>Male, No. (%)</b>	971 (46.4)	493 (47.4)	478 (45.4)
<b>Living arrangements before admission, No. (%)</b>			
Independent	1814 (86.7)	883 (84.9)	931 (88.5)
Nursing home	49 (2.3)	27 (2.6)	22 (2.1)
Senior residence/Assisted living	168 (8.1)	91 (8.8)	77 (7.3)
Missing	60 (2.9)	38 (3.7)	22 (2.1)
<b>Marital status, No. (%)</b>			
Married or living together	1125 (53.8)	556 (53.5)	569 (54.1)
Single or divorced	456 (21.8)	212 (20.4)	244 (23.2)
Widow/widower	435 (20.8)	224 (21.6)	211 (20.1)
Missing	75 (3.6)	47 (4.5)	28 (2.7)
<b>Charlson Comorbidity Index<sup>b</sup> (mean, SD<sup>a</sup>)</b>	2.05 (2.05)	2.10 (2.08)	2.01 (2.03)
<b>Polypharmacy, No. (%)<sup>c,d,e</sup></b>	1247 (59.6)	586 (56.4)	661 (62.8)
Missing	12 (.6)	8 (.8)	4 (.4)
<b>Hospitalization in past 6 months, No. (%)</b>	705 (33.7)	339 (32.6)	336 (34.8)
<b>Acute hospitalization, No. (%)<sup>c,f</sup></b>	73.0 (73.0)	725 (69.8)	801 (76.1)
<b>Admission ward, internal medicine No. (%)</b>	1051 (50.3)	524 (50.4)	527 (50.1)
<b>Discharge destination, No. (%)</b>			
Home	1551 (74.2)	770 (74.1)	781 (74.2)
Other health care setting, of which	482 (23.1)	238 (23.0)	244 (23.2)
Rehabilitation center	268 (12.8)	120 (11.5)	148 (14.1)
Nursing home	158 (7.6)	80 (7.7)	78 (7.4)
Assisted living	34 (1.6)	26 (2.5)	8 (0.8)
Other hospital	22 (1.1)	12 (1.2)	10 (1.0)
Missing	58 (2.8)	31 (3.0)	27 (2.6)

<sup>a</sup> Standard Deviation, <sup>b</sup> Range of 0 to 31, with a higher score indicating more or more severe comorbidity<sup>33</sup>, <sup>c</sup> Use of 5 or more different medications, <sup>d</sup> Chi-Square, <sup>e</sup> P-value = 0.004, <sup>f</sup> P-value = 0.001

**Table 2.** Interrupted time series analysis; medical and nursing handovers

	<i>Medical handovers &lt;24 hrs after discharge (%)<sup>a</sup></i>			<i>Time between discharge and medical letter (days)<sup>b</sup></i>			<i>Nursing handovers &lt;24 hrs after discharge (%)<sup>a</sup></i>		
	$\beta$ (SE)	95% CI	p-value	$\beta$ (SE)	95% CI	p-value	$\beta$ (SE)	95% CI	p-value
Intercept	17.51 (3.79)	10.08 to 24.93	<0.01	7.20 (0.29)	6.63 to 7.76	<0.01	91.85 (2.71)	86.53 to 97.16	<0.01
Trend pre-intervention ( $\beta_1$ )	1.49 (0.97)	-0.42 to 3.40	0.16	-0.30 (0.07)	-0.45 to -0.16	<0.01	0.28 (0.70)	-1.09 to 1.64	0.70
Level change directly after intervention ( $\beta_2$ )	6.43 (10.13)	-13.43 to 26.28	0.54	-0.62 (0.74)	-2.07 to 0.84	0.43	6.32 (7.25)	-7.89 to 20.53	0.41
Trend differences ( $\beta_3$ )	-0.94 (1.38)	-3.64 to 1.75	0.51	0.05 (0.10)	-0.14 to 0.25	0.61	-0.81 (0.99)	-2.74 to 1.12	0.43
	Absolute effect directly after intervention: -0.17%			Absolute effect directly after intervention: -0.25 days			Absolute effect directly after intervention: 0.62%		

$\beta_1$  estimates the pre-intervention slope.

$\beta_2$  estimates the difference between the observed level just after the intervention started and that predicted by the pre-intervention slope.

$\beta_3$  estimates the difference in trend/slopes between the pre-intervention and post-intervention period.

SE: Standard Error, CI: Confidence Interval



**Figure 1. Pyramid for post-discharge care**

A structured discharge process such as the TIP procedure should form the basis for every patient. For patients discharged with post-discharge care (20-25%), nursing handovers should be set up within 48h after admission and be sent within 24h post-discharge. Complex patients with a high readmission risk (10%) require a (nurse) case manager or transitional care in the transition from hospital to home.

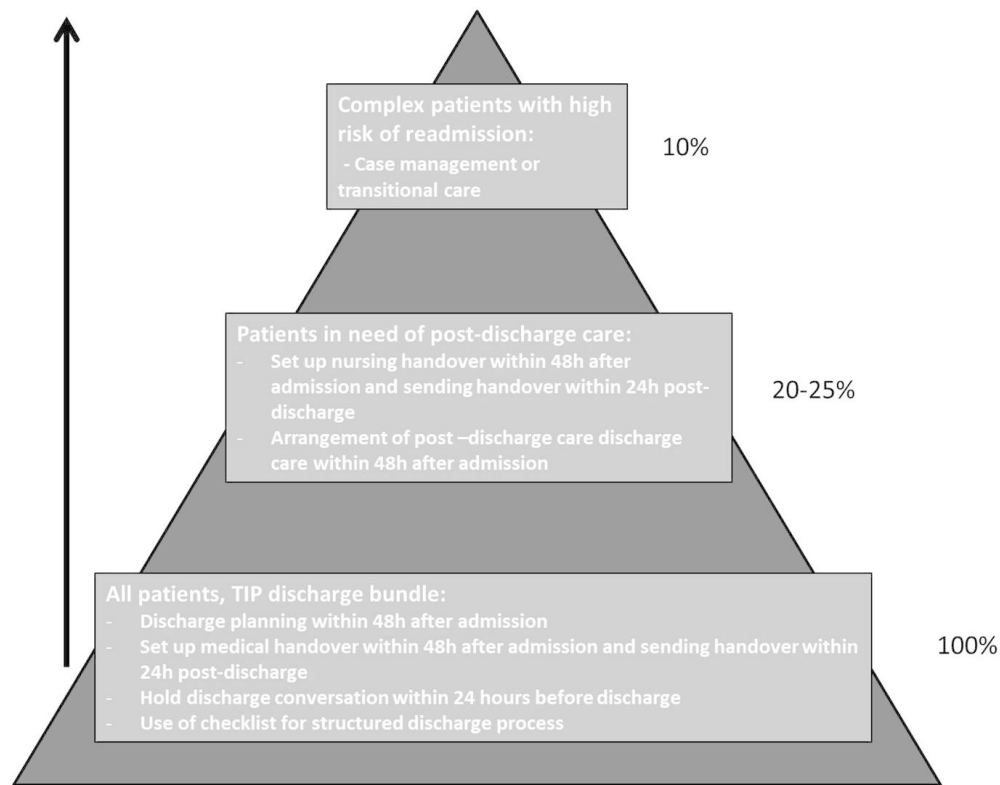
**Figure 2.**

**Panel A** The number of medical handovers sent within 24 hours.

**Panel B** median time in days between discharge and the medical handovers.

**Figure 3. Hospital differences based on implementation score.**

The inter-hospital differences in rates of medical handovers being sent within 24h in the pre- and post-intervention based on the extent of implementation and used implementation strategies. Group 1 received >30 feedback implementation points, group 2 received 20-30 implementation points, group 3 received <20 points.



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Figure 1. Pyramid for post-discharge care

A structured discharge process such as the TIP procedure should form the basis for every patient. For patients discharged with post-discharge care (20-25%), nursing handovers should be set up within 48h after admission and be sent within 24h post-discharge. Complex patients with a high readmission risk (10%) require a (nurse) case manager or transitional care in the transition from hospital to home. Adapted from van Seben et al.<sup>40</sup>

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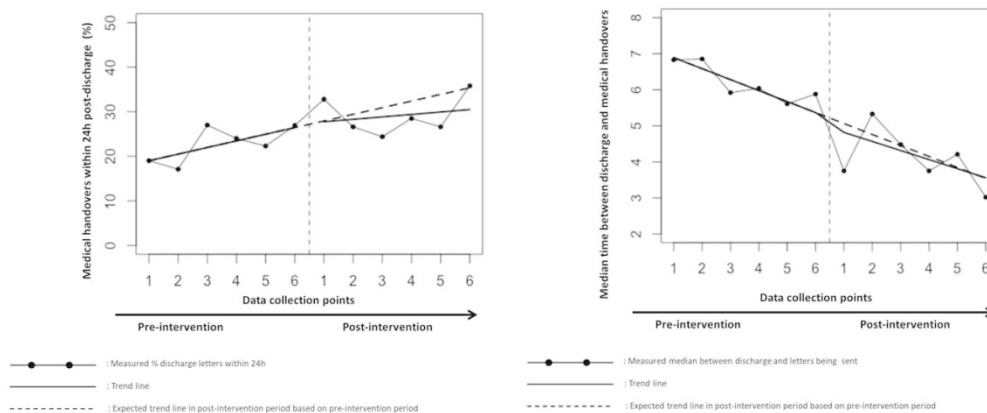


Figure 2.  
 Panel A The number of medical handovers sent within 24 hours.  
 Panel B median time in days between discharge and the medical handovers.

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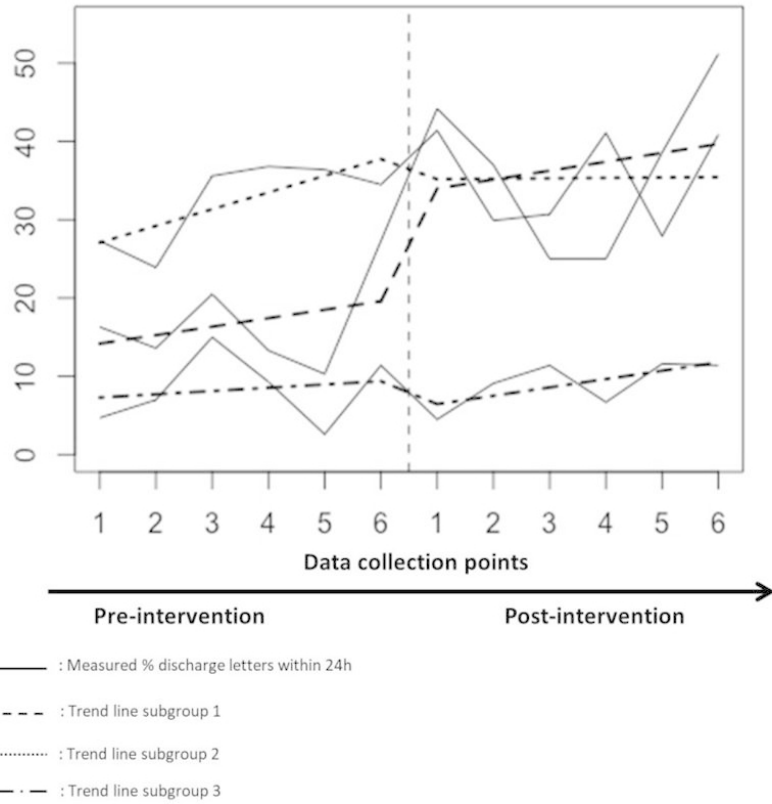


Figure 3. Hospital differences based on implementation score. The inter-hospital differences in rates of medical discharge letters being sent within 24h in the pre- and post-intervention based on the extent of implementation and used implementation strategies. Group 1 received >30 feedback implementation points, group 2 received 20-30 implementation points, group 3 received <20 points.

82x69mm (300 x 300 DPI)

**Supplement Table 1.** Adherence to the Intervention Protocol

	Hospital 1	Hospital 2	Hospital 3	Hospital 4	Hospital 5	Hospital 6	Hospital 7	Hospital 8
Pre-intervention	Sep '15 - Feb '16	Oct '15 - March '16	Jan '16 - June '16	Dec '15 - May '16	March '16 – Aug '16	April '16 – Sep '16	May '16 – Oct '16	April '16 – Sep '16
Implementation	March '16 - April '16	April '16 - May '16	July '16 - Aug '16	June '16 - July '16	Sep '16 - Oct '16	Oct '16 - Nov '16	Nov '16 - Dec '16	Oct '16 - Nov '16
Post-intervention	May '16 – Oct '16	June '16 - Nov '16	Sep '16 – Feb '17	Aug '16 - Jan '16	Nov '16 – April '17	Dec '16 – May '17	Jan '17 – June '17	Dec '16 – May '17
<b>Leadership and education of project leaders</b>								
Who were present at the kick off meeting February, 2016?	Hospital president; local project leader; 2 team leaders (nurses); 2 physicians; nurse; pharmacists	Local project leader; geriatrician; head of the liaison department; physician	2 local project leaders; head of the liaison department	Chief of staff; local project leader; team leader surgery ward (nurse); head of the liaison department	Local project leader; head of the liaison department; manager patient logistics; 2 team leaders (nurses)	2 local project leaders	Local project leader	Local project leader; senior researcher transitional care; medical specialist,
Who were present at the first feedback session?	Project leader; head of the liaison department	Project leader; pharmacist; communication assistant	2 local project leaders; liaison nurse	Project leader; liaison nurse; nurse geriatrics	Local project leader	2 local project leaders	-	2 project leaders
Who were present at the second feedback session?	Project leader	Project leader	2 project leaders	-	Project leader	-	Project leader	2 project leaders
<i>Implementation points</i>	10	8	8	7	7	4	2	7
<b>Project group</b>								
Was there a local TIP project group, and who participated?	Yes, project leader; 2 senior nurses of participating wards, management assistant	Yes, project leader; geriatrician; head liaison department, physician; pharmacist; communication assistant; manager Security & Services	Yes, 2 project leaders; 2 residents; 2 medical specialists; nurse; liaison nurse; pharmacist; manager	Yes, chief of staff; project leader; 2 team leaders (nurses); head liaison department; orthopedist	Yes, project leader; head liaison department; 2 medical specialists, geriatrician	No	No	Yes, local project leader; 3 medical specialists; 2 residents, manager quality and safety; manager process optimization; medical director
How often did the local project group meet? 1 point per meeting	Monthly for 2 months, during pilot period every week (2 months).	Every five weeks during pre-intervention and pilot period	2 times, before pilot period.	Every two weeks during pre-intervention period	Every six weeks, during pre-intervention and pilot period	-	-	Monthly during pre-intervention, pilot period and first two months of post-

								intervention period
<i>Implementation points</i>	10	12	10	18	10	0	0	17
<b>Implementation of TIP elements</b>								
Was it policy to set a discharge date within 48h after admission?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Was the planned discharge date communicated to patients?	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Was it policy to start with arrangement of required post-discharge care within 48h after admission?	No, liaison nurse has to wait for final discharge date	No, liaison nurse has to wait for final discharge date	Yes	Yes	No, liaison department is overloaded	Yes	No, liaison nurse has to wait for final discharge date	Yes
Was it policy to set up patient handovers within 48h after admission?	No	No	No	No	No	No	No	No
Did physicians hold discharge conversations, using a checklist during the pilot period?	No	No	No	No	No	No	No	No
Does the nurse holds a discharge conversation, using a checklist?	Yes	No	Yes	Yes	Yes	No	Yes	Yes
Was the patient discharge letter implemented?	Yes, but only for some diagnosis at internal medicine ward.	No	No	No	No	Yes, but only at internal medicine ward for frail older patients.	No	No, a discharge summary was implemented instead.
<i>Implementation points</i>	3.5	2	4	4	3	2.5	3	4.5
<b>Education of physicians and nurses</b>								

1	How were physicians and nurses informed about the TIP and how often?	Kick-off meeting at participating wards; during morning report; working instructions were sent by email to all physicians	Kick-off meeting; meeting at participating wards; E-learning; 1 feedback meeting	During morning reports; project leader informed every physician separately; intranet; email	During morning reports; intranet; email; posters & pocket cards; and project leaders went to participating wards to inform physicians and nurses	Email and project leader went to participating wards	Kick-off meeting, during several morning reports	Physicians were not educated with regard to the intervention	During several morning report; email; project leaders went to participating wards to inform physicians and nurses; medical specialists from project group informed physicians in person									
2	Did physicians and/or nurses receive feedback with regard to their discharge letters and if yes, how often?	No	No	No	No	No	Only for nurses	No	Yes, daily on internal medicine and monthly on surgery ward, via email.									
3	<i>Implementation points</i>	3	4	4	5	2	2.5	0	5									
4	<b>Total implementation points</b>	<b>26.5</b>	<b>26</b>	<b>26</b>	<b>34</b>	<b>22</b>	<b>9</b>	<b>5</b>	<b>33.5</b>									
5	<b>Pre-intervention vs. post-intervention period scores</b>																	
6	<b>Pre-intervention period</b>																	
7	median	% letters within 24h	8.15	9.0	0.90	47.3	6.71	23.5	10.48	13.1	0.79	50.0	6.79	9.2	14.21	7.6	5.83	20.9
8	<b>Post-intervention</b>																	
9	median	% letters within 24h	9.08	19.5	1.0	48.5	5.48	24.2	5.79	19.7	0.29	49.6	7.98	16.7	22.44	1.5	0.83	53.8

**Revised Standards for Quality Improvement Reporting Excellence (SQUIRE 2.0)  
September 15, 2015**

Text Section and Item Name	Section or Item Description
<b>Notes to authors</b>	<ul style="list-style-type: none"> <li>• The SQUIRE guidelines provide a framework for reporting new knowledge about how to improve healthcare</li> <li>• The SQUIRE guidelines are intended for reports that describe <a href="#">system</a> level work to improve the quality, safety, and value of healthcare, and used methods to establish that observed outcomes were due to the <a href="#">intervention(s)</a>.</li> <li>• A range of approaches exists for improving healthcare. SQUIRE may be adapted for reporting any of these.</li> <li>• Authors should consider every SQUIRE item, but it may be inappropriate or unnecessary to include every SQUIRE element in a particular manuscript.</li> <li>• The SQUIRE Glossary contains definitions of many of the key words in SQUIRE.</li> <li>• The Explanation and Elaboration document provides specific examples of well-written SQUIRE items, and an in-depth explanation of each item.</li> <li>• Please cite SQUIRE when it is used to write a manuscript.</li> </ul>
<b>Title and Abstract</b>	
<b>1. Title</b>	Indicate that the manuscript concerns an <a href="#">initiative</a> to improve healthcare (broadly defined to include the quality, safety, effectiveness, patient-centeredness, timeliness, cost, efficiency, and equity of healthcare)
<b>2. Abstract</b>	<ol style="list-style-type: none"> <li>a. Provide adequate information to aid in searching and indexing</li> <li>b. Summarize all key information from various sections of the text using the abstract format of the intended publication or a structured summary such as: background, local <a href="#">problem</a>, methods, interventions, results, conclusions</li> </ol>
<b>Introduction</b>	<i>Why did you start?</i>
<b>3. <a href="#">Problem Description</a></b>	Nature and significance of the local <a href="#">problem</a>
<b>4. Available knowledge</b>	Summary of what is currently known about the <a href="#">problem</a> , including relevant previous studies



1 2 3 4 5 6 7	<b>5. <a href="#">Rationale</a></b>	Informal or formal frameworks, models, concepts, and/or <a href="#">theories</a> used to explain the <a href="#">problem</a> , any reasons or <a href="#">assumptions</a> that were used to develop the <a href="#">intervention(s)</a> , and reasons why the <a href="#">intervention(s)</a> was expected to work
8 9	<b>6. Specific aims</b>	Purpose of the project and of this report
10 11	<b>Methods</b>	<i>What did you do?</i>
12 13	<b>7. <a href="#">Context</a></b>	Contextual elements considered important at the outset of introducing the <a href="#">intervention(s)</a>
14 15 16 17	<b>8. <a href="#">Intervention(s)</a></b>	a. Description of the <a href="#">intervention(s)</a> in sufficient detail that others could reproduce it b. Specifics of the team involved in the work
18 19 20 21	<b>9. Study of the Intervention(s)</b>	a. Approach chosen for assessing the impact of the <a href="#">intervention(s)</a> b. Approach used to establish whether the observed outcomes were due to the <a href="#">intervention(s)</a>
22 23 24 25 26 27 28	<b>10. Measures</b>	a. Measures chosen for studying <a href="#">processes</a> and outcomes of the <a href="#">intervention(s)</a> , including rationale for choosing them, their operational definitions, and their validity and reliability b. Description of the approach to the ongoing assessment of contextual elements that contributed to the success, failure, efficiency, and cost c. Methods employed for assessing completeness and accuracy of data
29 30 31 32 33	<b>11. Analysis</b>	a. Qualitative and quantitative methods used to draw <a href="#">inferences</a> from the data b. Methods for understanding variation within the data, including the effects of time as a variable
34 35 36 37	<b>12. Ethical Considerations</b>	<a href="#">Ethical aspects</a> of implementing and studying the <a href="#">intervention(s)</a> and how they were addressed, including, but not limited to, formal ethics review and potential conflict(s) of interest
38 39	<b>Results</b>	<i>What did you find?</i>
40 41 42 43 44 45 46 47 48 49 50	<b>13. Results</b>	a. Initial steps of the <a href="#">intervention(s)</a> and their evolution over time (e.g., time-line diagram, flow chart, or table), including modifications made to the intervention during the project b. Details of the <a href="#">process</a> measures and outcome c. Contextual elements that interacted with the <a href="#">intervention(s)</a> d. Observed associations between outcomes, interventions, and relevant contextual elements e. Unintended consequences such as unexpected benefits, problems, failures, or costs associated with the <a href="#">intervention(s)</a> . f. Details about missing data
51 52	<b>Discussion</b>	<i>What does it mean?</i>
53 54 55 56 57 58 59 60	<b>14. Summary</b>	a. Key findings, including relevance to the <a href="#">rationale</a> and specific aims b. Particular strengths of the project

<p>1 2 3 4 5 6 7 8 9 10 11</p> <p><b>15. Interpretation</b></p>	<p>a. Nature of the association between the <a href="#">intervention(s)</a> and the outcomes</p> <p>b. Comparison of results with findings from other publications</p> <p>c. Impact of the project on people and <a href="#">systems</a></p> <p>d. Reasons for any differences between observed and anticipated outcomes, including the influence of <a href="#">context</a></p> <p>e. Costs and strategic trade-offs, including <a href="#">opportunity costs</a></p>
<p>12 13 14 15 16</p> <p><b>16. Limitations</b></p>	<p>a. Limits to the <a href="#">generalizability</a> of the work</p> <p>b. Factors that might have limited <a href="#">internal validity</a> such as confounding, bias, or imprecision in the design, methods, measurement, or analysis</p> <p>c. Efforts made to minimize and adjust for limitations</p>
<p>17 18 19 20 21 22</p> <p><b>17. Conclusions</b></p>	<p>a. Usefulness of the work</p> <p>b. Sustainability</p> <p>c. Potential for spread to other <a href="#">contexts</a></p> <p>d. Implications for practice and for further study in the field</p> <p>e. Suggested next steps</p>
<p>23 24</p> <p><b>Other information</b></p>	
<p>25 26 27</p> <p><b>18. Funding</b></p>	<p>Sources of funding that supported this work. Role, if any, of the funding organization in the design, implementation, interpretation, and reporting</p>

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3 **Table 2. Glossary of key terms used in SQUIRE 2.0. This Glossary provides the intended**  
4 **meaning of selected words and phrases as they are used in the SQUIRE 2.0 Guidelines. They**  
5 **may, and often do, have different meanings in other disciplines, situations, and settings.**  
6

### 7 **Assumptions**

8 Reasons for choosing the activities and tools used to bring about changes in healthcare services at  
9 the [system](#) level.  
10  
11

### 12 **Context**

13 Physical and sociocultural makeup of the local environment (for example, external environmental  
14 factors, organizational dynamics, collaboration, resources, leadership, and the like), and the  
15 interpretation of these factors (“sense-making”) by the healthcare delivery professionals, patients,  
16 and caregivers that can affect the effectiveness and [generalizability](#) of [intervention\(s\)](#).  
17  
18

### 19 **Ethical aspects**

20 The value of [system](#)-level [initiatives](#) relative to their potential for harm, burden, and cost to the  
21 stakeholders. Potential harms particularly associated with efforts to improve the quality, safety, and  
22 value of healthcare services include [opportunity costs](#), invasion of privacy, and staff distress  
23 resulting from disclosure of poor performance.  
24  
25

### 26 **Generalizability**

27 The likelihood that the [intervention\(s\)](#) in a particular report would produce similar results in other  
28 settings, situations, or environments (also referred to as external validity).  
29  
30

### 31 **Healthcare improvement**

32 Any systematic effort intended to raise the quality, safety, and value of healthcare services, usually  
33 done at the [system](#) level. We encourage the use of this phrase rather than “quality improvement,”  
34 which often refers to more narrowly defined approaches.  
35  
36

### 37 **Inferences**

38 The meaning of findings or data, as interpreted by the stakeholders in healthcare services –  
39 improvers, healthcare delivery professionals, and/or patients and families  
40  
41

### 42 **Initiative**

43 A broad term that can refer to organization-wide programs, narrowly focused projects, or the details  
44 of specific interventions (for example, planning, execution, and assessment)  
45  
46

### 47 **Internal validity**

48 Demonstrable, credible evidence for efficacy (meaningful impact or change) resulting from  
49 introduction of a specific intervention into a particular healthcare [system](#).  
50  
51

### 52 **Intervention(s)**

53 The specific activities and tools introduced into a healthcare [system](#) with the aim of changing its  
54 performance for the better. Complete description of an intervention includes its inputs, internal  
55 activities, and outputs (in the form of a logic model, for example), and the mechanism(s) by which  
56 these components are expected to produce changes in a [system's](#) performance.  
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### 59 **Opportunity costs**

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3 Loss of the ability to perform other tasks or meet other responsibilities resulting from the diversion  
4 of resources needed to introduce, test, or sustain a particular [improvement](#) initiative  
5  
6

### 7 **Problem**

8 Meaningful disruption, failure, inadequacy, distress, confusion or other dysfunction in a healthcare  
9 service delivery [system](#) that adversely affects patients, staff, or the [system](#) as a whole, or that  
10 prevents care from reaching its full potential  
11

### 12 **Process**

13 The routines and other activities through which healthcare services are delivered  
14  
15

### 16 **Rationale**

17 Explanation of why particular [intervention\(s\)](#) were chosen and why it was expected to work, be  
18 sustainable, and be replicable elsewhere.  
19

### 20 **Systems**

21 The interrelated structures, people, [processes](#), and activities that together create healthcare services  
22 for and with individual patients and populations. For example, systems exist from the personal self-  
23 care system of a patient, to the individual provider-patient dyad system, to the microsystem, to the  
24 macrosystem, and all the way to the market/social/insurance system. These levels are nested within  
25 each other.  
26  
27

### 28 **Theory or theories**

29 Any “reason-giving” account that asserts causal relationships between variables (causal theory) or  
30 that makes sense of an otherwise obscure [process](#) or situation (explanatory theory). Theories come  
31 in many forms, and serve different purposes in the phases of [improvement](#) work. It is important to  
32 be explicit and well-founded about any informal and formal theory (or theories) that are used.  
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# BMJ Open

## A safe handover for every patient: an interrupted time series analysis to test the effect of a structured discharge bundle

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2018-023446.R2
Article Type:	Research
Date Submitted by the Author:	13-Feb-2019
Complete List of Authors:	van Seben, Rosanne; AMC, Internal Medicine, section of Geriatric Medicine Geerlings, Suzanne; AMC, Internal Medicine, Division of Infectious Diseases Maaskant, Jolanda; AMC, Emma Children's Hospital Buurman, Bianca; Academic Medical Center, Internal Medicine, section of Geriatric Medicine
<b>Primary Subject Heading</b>:	Health services research
Secondary Subject Heading:	Communication, Health services research
Keywords:	Discharge Bundle, Patient Handovers, Discharge Letter, Patient Safety, Interrupted Time Series, Quality Improvement

SCHOLARONE™  
Manuscripts

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3 **A safe handover for every patient: an interrupted time series analysis to test the effect of a**  
4 **structured discharge bundle**  
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8 Rosanne van Seben (corresponding author)

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## Abstract

**Objective** Patient handovers are often delayed, patients are hardly involved in their discharge process and hospital-wide standardized discharge procedures are lacking. The aim of this study was to implement a structured discharge bundle and to test the effect on timeliness of medical and nursing handovers, length of hospital stay (LOS) and unplanned readmissions.

**Design** Interrupted time series with six pre-intervention and six post-intervention data collection points (September 2015 through June 2017).

**Setting** Internal medicine and surgical wards.

**Participants** Patients ( $\geq 18$  years) admitted for more than 48h to surgical or internal medicine wards.

**Intervention** The Transfer Intervention Procedure (TIP), containing four elements: planning the discharge date within 48h post-admission, arrangements for postdischarge care, preparing handovers and personalized patient discharge letter; and a discharge conversation 12-24h before discharge.

**Outcome measures** The number of medical and nursing handovers sent within 24h. Secondary outcomes were median time between discharge and medical handovers, LOS and unplanned readmissions.

**Results** Pre-intervention 1039 and post-intervention 1052 patient records were reviewed. No significant change was observed in the number of medical and nursing handovers sent within 24h. The median (interquartile range) time between discharge and medical handovers decreased from 6.15 (0.96-15.96) to 4.08 (0.33-13.67) days, but no significant difference was found. No intervention-effect was observed for LOS and readmission. In subgroup analyses, a reduction of 5.6 days in the median time between discharge and medical handovers was observed in hospitals with high protocol adherence and much attention for implementation.

**Conclusion** Implementation of a structured discharge bundle did not lead to improved timeliness of patient handovers. However, large inter-hospital variation was observed and an intervention effect

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3 on the median time between discharge and medical handovers was seen in hospitals with high  
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5 protocol adherence. Future interventions should continue to create awareness of the importance of  
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7 timely handovers.  
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12 **Trial Registration:** Dutch Trial Registry: NTR5951  
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### 15 16 **Strengths and limitations of this study**

- 17  
18 • This study aimed to implement a structured discharge bundle to improve patient handovers  
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20 for every patient.
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22 • The study design, i.e. Interrupted Time Series Analysis, provided valuable information on pre-  
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24 intervention trends, which strengthens the results.
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26 • Sensitivity analysis provided important insight into the inter-hospital variation and  
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28 differences in intervention effects among hospitals.
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30 • Only the date of sending patient handovers were recorded. Knowing whether the next care  
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32 provider received information would have been informative.
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34 • It was not possible to evaluate percentages of compliance with the study protocol.  
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36 Therefore, the process evaluation with the project leaders might have been an  
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38 overestimation.  
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## Introduction

As hospital stays have become shorter and full recovery often takes place at home,<sup>1</sup> a safe transition from hospital to home or nursing home has become more and more important. Besides, a rising number of older chronically ill patients who move within the health care system, requires continuity of care<sup>2 3</sup>. However, transitions from hospital to primary care settings are still considered a high-risk process. Patients are discharged with little coordination or follow-up and are hardly involved in their own discharge process<sup>4 5</sup>.

Inadequate transitions may have serious implications for patient safety and quality of care. Postdischarge adverse events such as medication errors, can be the consequence of insufficient or lacking communication between hospital and primary care providers, thereby contributing to higher resource use and unplanned readmission rates<sup>6-11</sup>. In fact, unplanned readmission rates in the first month postdischarge are as high as 20%<sup>12</sup> and a recent study shows that half of them are deemed preventable<sup>11</sup>.

The root of a safe transition from hospital to home or nursing home is a timely transfer of the medical handover, that is a letter containing accurate medical discharge information for the next care provider<sup>8 13</sup>. The general practitioner (GP) can only take over responsibility for a patient safely, when receiving a medical handover containing accurate information on, e.g., medications, and follow-up<sup>13</sup>. Nonetheless, a review of Kripalani et al. showed that medical handovers are often not available, lack important information or are not sent in a timely manner<sup>8</sup>. Also, a more recent study performed in 20 Dutch hospitals showed that in 10% of cases medical handover were missing and the remainder was on average sent after one week,<sup>14</sup> even though unplanned readmissions most frequently occur within the first week postdischarge<sup>15</sup>.

Previous studies that aimed to improve patient handovers, mainly focused on specific high risk populations and targeted patient-related factors<sup>16-18</sup>. Although such interventions on individualized discharge planning or transitional care have been effective in reducing readmission<sup>16 17</sup>

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3 and postdischarge mortality rates,<sup>18-20</sup> organizational factors that form the basis of a safe handover  
4 should also be optimally arranged<sup>13 21</sup>. In fact, in order to ensure patient safety and continuity of care,  
5 early discharge planning, a structured discharge process and timely handovers might be essential<sup>13 21</sup>  
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<sup>22</sup>. Besides, given that patients are often unprepared at time of discharge and uncertainties about aspects such as treatment or medication may exist,<sup>5</sup> patient education, e.g., in terms of a proper discharge conversation, should also be an important aspect of the discharge process<sup>6 7</sup>.

The aim of this study was, therefore, to implement a structured discharge process, the Transfer Intervention Procedure (TIP), in eight hospitals. The TIP contains four elements: planning the discharge date within 48h after admission, arrangements for required postdischarge care, preparing medical, medication, and nursing handovers and a personalized discharge letter for the patient (PPDL) within 48h after admission; and holding a discharge conversation 12 to 24h before discharge. We tested whether the TIP improved timeliness of medical and nursing handovers and investigated the effect of the TIP procedure on length of hospital stay and unplanned readmissions within 30-days postdischarge.

## Methods

### *Study design and setting*

We evaluated the implementation of the TIP discharge bundle in an interrupted time series (ITS), which is the strongest design when a randomized controlled trial is not feasible<sup>23 24</sup>. The trial protocol<sup>25</sup> was based on the recommendations for ITS studies,<sup>23</sup> and we adhered to the SQUIRE guidelines for quality improvement reporting<sup>26</sup>. The current study was part of a large national program, initiated by the Dutch Ministry of Health, Welfare, and Sport (abbreviated in Dutch: VWS): 'Addressing Waste in Health Care'. This program was set up in order to reduce inefficiencies in the provision of health care. As part of this program, a TIP study group was established, comprising a study coordinator, two supervisors, one clinical epidemiologist, a policy officer from the Ministry of

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3 VWS and local project leaders from the eight participating hospitals (one university and seven  
4 regional teaching throughout the Netherlands) that implemented the TIP bundle at one of their  
5 surgical and one of their internal medicine wards.  
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10         Within an interrupted time series, repeated observations are collected over time and divided  
11 into two segments, one before and one after implementation. Therefore, at six pre-intervention data  
12 collection points, measurements were conducted before implementation of the TIP and at six post-  
13 intervention data collection points measurements were conducted after implementation. During the  
14 implementation period of two months no measurements were conducted. February 2016, a kick off  
15 meeting was held. Between March 2016 and November 2016, hospitals started with implementation.  
16 Data collection started September 2015 and ended June 2017 (Supplement Table 1). All patients  
17 (aged  $\geq 18$  years) admitted for more than 48h were eligible for inclusion. The Medical Ethics Research  
18 Committee (METC) confirmed that the Medical Research Involving Human Subjects Act did not apply  
19 to this research project and official approval was not required. Since the study involved a quality  
20 improvement intervention with negligible risk of harming patients, individual informed consent was  
21 waived for all participating hospitals by the legal department research support of the Amsterdam  
22 UMC, location AMC. This trial was registered with the Dutch Trial Registry number NTR5951.  
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#### 41 *The discharge process in the Netherlands*

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43 In the Netherlands, primary care standards are relatively high and basically every person has a  
44 general practitioner (GP). When a person is hospitalized, responsibility is taken over from the GP by  
45 the medical specialist. After discharge, patient care becomes the responsibility of the GP again. It is  
46 policy for hospitals to provide patient handovers to the GP. However, there are no clear guidelines  
47 for hospitals how to arrange their discharge process. The Dutch healthcare inspectorate,<sup>27</sup> indicated  
48 that standardized discharge processes are lacking and errors that occur during handovers are often  
49 resolved informally.  
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3 After discharge from the hospital, the hospital physician sends a medical handover to the  
4 primary care provider for every patient (e.g., nursing home physician or the GP). Medical handovers  
5 include information on the reason for admission, diagnosis, comorbidity, the course of admission,  
6 medical examinations, treatment, medication, the health status of the patient at discharge, and  
7 instructions on follow-up<sup>28</sup>. Nursing handovers are only provided when the patient is discharged to a  
8 nursing home or with postdischarge care at the patient's own home. Nursing handovers include  
9 information on the care provided during hospitalization, current nursing care problems, the reason  
10 why (nursing) home care is initiated, and the intended outcomes of the care that will be provided<sup>29</sup>.  
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### 23 *Intervention*

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25 Figure 1 (adapted from van Seben et al.<sup>30</sup>) illustrates how the TIP bundle forms the basis of a safe  
26 handover from hospital to primary care for every patient, and if applicable, for patients discharged  
27 with postdischarge care (e.g., home care or a nursing home) or for complex patients who require a  
28 case manager or transitional care. As described in two previous studies,<sup>25 31</sup> the TIP bundle was  
29 developed using input from focus group meetings with professionals, patient surveys and literature.  
30 The TIP discharge bundle consists of four elements: 1) planning the discharge date within 48h after  
31 admission and communication of the discharge date with the patient, 2) starting with arrangements  
32 for required postdischarge care within 48h after admission; 3) preparing patient handovers (medical,  
33 medication, nurse) and personalized patient discharge letter (PPDL<sup>32</sup>) within 48h after admission, 4)  
34 planning a discharge conversation with the patient to explain information from the PPDL 12-24h  
35 before discharge. The PPDL is a standardized document, containing understandable information for  
36 the patient on the reason for admission, hospital treatment, course of the disease, possible sustained  
37 consequences or complications, and information on medication. We constructed checklists based on  
38 the TIP, which served as remembering tool for nurses and physicians in the electronic system or on  
39 pocket cards.  
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### *Patient and public Involvement*

Our research question was developed from the perspective that patients are discharged with little coordination or follow-up and that they are often unprepared at time of discharge<sup>4 5</sup>. Patients were involved as participants in the construction of the TIP discharge bundle, which was based on, among others, patient satisfaction surveys<sup>25 31</sup>. Further, in a previous study in which the PPDL was developed and implemented, patient satisfaction with the PPDL was also assessed<sup>32</sup>.

### *Protocol adherence*

To enhance intervention fidelity and protocol adherence in the different hospitals, regular meetings were held with the TIP study group to report results and provide feedback, to discuss implementation, share experience and learn from each other's practices. A process evaluation was conducted with the project leaders to investigate protocol adherence, implementation strategies and attention paid to implementation. Elements that were considered included leadership and education of project leaders, projects group, extent of implementation of the discharge bundle, and education of physicians and nurses. Feedback points were awarded for all elements and for the extent to which the hospital complied to a certain element, e.g., for every person present at the kick off meeting or for every project meeting that was held. When a hospital partly complied to an element, e.g. automatically generated discharge summaries were provided to the patient instead of a PPDL or feedback on timely handovers was only provided to nurses, 0.5 feedback points were awarded. It was not possible to evaluate percentages of compliance with discharge conversations, planning discharge dates and arrangement of postdischarge care within 48h since these aspects were not reported in patient records. Hospital policies regarding these elements were assessed.

### *Outcome measures*

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3 Our primary outcome was the number of medical and nursing handovers sent within 24h. This time-  
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5 frame was based on a report of the Dutch healthcare inspectorate (In Dutch: Inspectie voor de  
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7 Gezondheidszorg en Jeugd (IGJ)) on the discharge process and handovers, in which it is stated that  
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9 accurate information needs to be available as quick as possible, but certainly within 24h, for the next  
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11 care provider<sup>27</sup>. Medical handovers also include medication handovers and we considered the time  
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13 that these handovers were sent to the GP. The median time between discharge and the medical  
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15 handover was considered as secondary outcome. Further, secondary outcomes were length of  
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17 hospital stay (LOS) and rates of unplanned readmission within 30 days.  
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### 23 *Baseline data collection*

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25 Data regarding patient characteristics included: demographics, admission ward and medical data (i.e.  
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27 presence of polypharmacy, comorbidity,<sup>33</sup> number of hospitalization in the six months prior to  
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29 current hospitalization). Variables were all collected from patient files. All data were reported and  
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31 analyzed anonymously.  
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### 37 *Sample size calculation*

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39 Based on the findings of a previous study<sup>31</sup> we expected to find a reduction of 78% in the time  
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41 between discharge and medical handovers sent. We conducted a power analysis with a number of  
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43 patients based on the number of hospital beds at the participating wards and feasibility with regards  
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45 to data collection, which was set at 11 patients. In a simulation study with 16 wards, each  
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47 contributing 65 patients, we estimated the power to be approximate 91% to demonstrate a  
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49 reduction of 78% in time until sending the medical handover, assuming that the intraclass correlation  
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51 coefficient does not exceed 0.05.  
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### 57 *Statistical analysis*

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3 Descriptive characteristics of patients were calculated using proportions, means and standard  
4 deviations (SD), or medians and interquartile ranges (IQR), as appropriate. Chi-squared analysis and  
5 the Mann Whitney test were used to compare pre-intervention and post-intervention patient  
6 characteristics. Our time series was divided into two segments, one before and one after  
7 implementation of the TIP and we used segmented regression analysis to detect post-intervention  
8 level changes (i.e., an immediate change in the observed outcome after implementation) and  
9 changes in post-intervention trends relative to pre-intervention trends (i.e., a change in slopes of the  
10 regression lines after implementation). A least square regression line was fitted to the two segments  
11 of the continuous time variable. The segmented regression helped us to estimate the change in the  
12 intercept and the slope coefficients between the pre-intervention and post-intervention period using  
13 the following model:  $Y_t = \alpha + \beta_1 \text{time}_t + \beta_2 \text{intervention}_t + \beta_3 \text{time after intervention}_t + \varepsilon_t$ . Since observations  
14 over time are correlated, we explored models with no, a first order autoregressive correlation  
15 between consecutive data collection periods, and longer autocorrelation structures.<sup>24</sup> We used the  
16 Akaike Information Criterion (AIC) as an estimator of the relative quality of a model and we report  
17 the results from the best fitting model. Correction for baseline imbalances as potential confounders  
18 led to results with similar estimates and identical interpretation. Based on the extent of protocol  
19 adherence and the feedback points awarded, subgroup analyses were performed to assess the  
20 intervention effect on the number of medical handovers within 24h and the median time between  
21 discharge and medical handovers. Statistical analyses were performed using SPSS Statistics ©,  
22 version 24.0, and Rstudio, version 1.0.136 (© 2009 – 2016 Rstudion, Inc).

## 50 Results

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52 A total of 2091 patient records (1039 pre- and 1052 post-intervention) were reviewed in order to  
53 investigate the effect of the Transfer Intervention Procedure (TIP) on the timeliness of medical and  
54 nursing handovers, length of hospital stay (LOS) and unplanned readmission within 30 days. Overall  
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3 patients had a mean age (SD) of 68.1 (16.6) and 46.4% were male (table 1). There were significant  
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5 differences between the pre-, and post-intervention group with regard to polypharmacy and the  
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7 ratio of acute/elective hospitalizations and these variables were considered as potential  
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9 confounders. However, correction for these potential confounders did not provide better models  
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12 than the presented models.  
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### 16 *Protocol adherence*

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18 Implementation strategies and protocol adherence are summarized in Supplement Table 1. Based on  
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20 the process evaluation, three subgroups were identified. Subgroup 1 (hospitals 4 and 8), >30  
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22 feedback points, paid considerable attention to implementation and there was relatively high  
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24 protocol adherence. In subgroup 2 (hospitals 1-3, and 5), 20-30 feedback points, there was relatively  
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26 high protocol adherence but moderate attention to implementation. In subgroup 3 (hospitals 6 and  
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28 7), <10 feedback points, nearly no attention was brought to implementation and there was low  
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30 compliance.  
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### 36 *Medical and nursing handovers*

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38 In the total study population, no intervention effect was found on the percentage of medical  
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40 handovers being sent within 24h after hospital discharge to the GP: 22.7% medical handovers were  
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42 sent within 24h pre-intervention, 29.1% post-intervention and no significant difference was observed  
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44 in the levels and trends between the pre-intervention and post-intervention period. The median  
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46 (interquartile range, IQR) time between discharge and medical handovers decreased from 6.15 (0.96-  
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48 15.96) days, pre-intervention to 4.08 (0.33-13.67) days post-intervention. An absolute effect directly  
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50 after the implementation of the intervention of -0.25 days was found (i.e., de difference in time  
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52 between discharge and medical handovers between the sixth pre-intervention data collection point  
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54 and first post-intervention data collection point). We observed no significant difference in the levels  
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3 and trends. The number of nursing handovers sent within 24h postdischarge was 92.8% pre-  
4 intervention and 93.1% post-intervention and no significant difference was observed between levels  
5 and trends. The results are presented in Figure 2 and the parameters estimates are summarized in  
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10 Table 2.

#### 11 12 13 14 *Length of hospital stay and unplanned readmission rates*

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16 No significant decline in the levels and trends between the pre-, and post-intervention was found  
17 with regard to LOS ( $\beta$  0.08, 95% CI -0.12 to 0.29  $p=0.45$ ) and unplanned readmission rates ( $\beta$  1.11,  
18 95% CI -2.55 to 0.33  $p=0.17$ ). Median (IQR) LOS was 8.17 (4.75-15.13) and 8.56 (4.88-15.91) days and  
19 readmissions rates were as high as 11.1% and 12.3% pre-intervention and post-intervention,  
20 respectively. With regard to LOS, the results are adjusted for autocorrelation (AIC 22.64 versus 33.75,  
21  $p=0.01$ ), but not for potential confounders (AIC 43.08 versus 33.75,  $p=0.07$ ). With regard to  
22 unplanned readmission rates, the results are unadjusted for autocorrelation (AIC 57.18 versus 54.45,  
23  $p=0.10$ ) and potential confounders (AIC 57.47 versus 54.45,  $p=0.61$ ).  
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#### 36 37 *Subgroup analysis*

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39 In subgroup 1 (>30 feedback points), an absolute effect of 13.3% more medical handovers sent  
40 within 24h postdischarge was observed but this did not result in significant changes in level or trends  
41 (Figure 3). A reduction of 5.6 days in the median time between discharge and handovers with a  
42 significant change in level directly after the intervention was observed in subgroup 1 ( $\beta$  -5.29, 95% CI  
43 -8.70 to 1.87  $p=0.02$ ). Pre-intervention, group 2 (20-30 feedback points) had the highest rate of  
44 medical handovers sent within 24h and the lowest median time between discharge and medical  
45 handovers but no intervention effect was observed. Both pre- and post-intervention, subgroup 3  
46 (<10 points) had the lowest rates of medical handovers sent within 24h, and the highest median  
47 time. We observed no intervention effect in subgroup 3.  
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## Discussion

In the total study population, a structured discharge bundle, the Transfer Intervention Procedure (TIP), did not lead to improved timeliness of medical and nursing handovers. Although medical handovers were sent faster post-intervention (pre-intervention median 6.15; post-intervention 4.08 days), we were unable to show significant differences in level and trends, both with regard to the median time and the number of medical handovers sent within 24h. However, large inter-hospital variation was observed and a significant intervention effect on the median time between discharge and medical handovers was seen in those hospitals with relatively high protocol adherence and attention for implementation. Rates of nursing handovers sent within 24h were both pre- and post-intervention above 90%. No intervention effect was found for length of hospital stay (LOS) and readmissions.

Extensive research has been conducted to improve patient handovers from hospital to home<sup>7</sup> <sup>16</sup>. Summarizing findings of earlier discharge interventions that aimed to improve coordination of care and communication between hospital and primary care providers, Hesselink et al.,<sup>7</sup> and Kripalani et al.,<sup>8</sup> showed that some studies were able to improve timeliness of medical handovers. These interventions, however, were based on the introduction of fax, email or web-based transfers of information, which is increasingly becoming standard practice in Dutch hospitals. Yet, further improvement may lie in electronic sending systems that support the use of standardized formats that pull information from patient files into (medical) handovers or that send information to the next care provider automatically.

Although a before-after design would probably have led to a significant intervention-effect, the ITS analysis provided valuable information on pre-intervention trends. The observed median time between discharge and sending medical handovers at our first pre-intervention measurement point was consistent with a recent Dutch study<sup>14</sup>, but a trend towards sending handovers faster was

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3 already observed along the pre-intervention period. During the pre-intervention period, no  
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5 interventions were implemented and the TIP was introduced and implemented during a two-month  
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7 implementation period during which no measurements were conducted. However, in the pre-  
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9 intervention period, attention was already brought to the discharge process, e.g. by establishing  
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11 project groups and the kick-off meeting. Although these activities were not intended as  
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13 implementation strategies, in hindsight they might explain why improvements were already  
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15 observed during the pre-intervention period, particularly since education on the importance of the  
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17 intervention is an important aspect of implementation<sup>13 34 35</sup>.

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21 Although positive trends in the pre-intervention period were less pronounced in the  
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23 subgroup analysis, results of the separate analyses support the idea that attention is important.  
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25 Whereas a significant reduction of six days in the median time between discharge and medical  
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27 handovers was observed in hospitals that paid much attention to implementation, no intervention  
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29 effect was observed in hospitals that paid moderate to nearly no attention. It should be noted that  
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31 the hospitals that paid moderate attention had relatively good pre-intervention scores. A smaller  
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33 window for improvement in these hospitals might also explain a lack of intervention effect<sup>36</sup>.

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37 Implementation of the TIP procedure did not reveal a reduction of LOS. Although a possible  
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39 explanation can be low overall compliance with our study protocol, it is also plausible that over the  
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41 past years, average LOS has decreased to a minimum<sup>37</sup>. Given current pressure on availability of  
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43 hospital beds, patients are discharged as soon as possible. This may account for inadequate discharge  
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45 processes, since physicians are forced to prioritize acute health care over discharge-related tasks<sup>38 39</sup>.

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48 Given increasingly shorter LOS<sup>37</sup> and the often complex care needs patient face, patient  
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50 preparation should be an important aspect of the discharge process. In fact, the most effective  
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52 discharge interventions seem to have educational components<sup>40</sup>. Unfortunately, given the workload  
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54 among residents, implementation of a personalized patient discharge letter was unsuccessful. E.g.,  
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56 posing the question “do you feel ready to go home”<sup>41</sup> or postdischarge telephone contact,<sup>7</sup> might be  
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3 less time-consuming ways to involve patients. However, to prevent readmissions more effort might  
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5 be necessary. Previous interventions that revealed a reduction in readmission rates, consist of  
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7 individualized discharge planning or continue postdischarge<sup>16 42</sup>. However, we believe that a  
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9 structured discharge process such as the TIP should form the basis for a safe handover for every  
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11 patient (Figure 1).  
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### 16 *Implications for further research*

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18 Our study shed light on the difficulties that come along with implementation of quality improvement  
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20 collaboratives<sup>43</sup>. Given the positive pre-intervention trends and significant reduction in the median  
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22 time between discharge and medical handovers in hospitals that paid much attention to  
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24 implementation, further improvements may lie in interventions that create more awareness of the  
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26 importance of timely handovers and hospital physicians' crucial role in the provision of continuity of  
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28 care. This might stimulate physicians' intrinsic motivation to provide a structured discharge process  
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30 and thereby timely handovers<sup>7 39</sup>. Furthermore, we might also want to focus on local factors that lead  
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32 to insufficient discharge processes. A comprehensive exploration of local barriers for each step in the  
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34 TIP discharge process might be helpful in order to develop tailor made interventions on a local or  
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36 department level to improve the discharge process<sup>44</sup>.  
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### 43 *Limitations*

44  
45 An interrupted time series provides a strong quasi-experimental design to evaluate the impact of an  
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47 intervention aimed at quality improvement. However, this study design also has limitations. First of  
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49 all, a positive trend towards sending handovers faster along the pre-intervention period, which was  
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51 probably due to the attention that was already brought to the discharge process before  
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53 implementation of the discharge bundle. In fact, an important limitation of ITS is that it is more  
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55 difficult to determine whether the observed effect is a direct effect of the intervention, in contrast to  
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3 e.g., clustered trials. Second, medical staff was not blinded for the outcome measure, that is timely  
4 discharge letters. Knowing that timeliness of discharge letters was monitored might have altered our  
5 results. However, in most hospitals timeliness of discharge letters was already monitored before we  
6 started with our research project and the effect is likely to be minimal. Third, we only recorded the  
7 date of sending medical handovers. Knowing whether they were received by GPs would also have  
8 provided valuable information. Fourth, we did not look at the content of handovers, while this might  
9 have given us important insights. Lastly, it was not possible to evaluate percentages of protocol  
10 adherence and the process evaluation with the project leaders might have been an overestimation.  
11 However, the process evaluation was in line with the efforts observed during implementation.  
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## 26 **Conclusion**

27 Implementation of a structured discharge bundle, the Transfer Intervention Procedure (TIP), did not  
28 lead to more medical and nursing handovers sent within 24h postdischarge. Large inter-hospital  
29 variation was observed however, and a significant intervention effect on the median time between  
30 discharge and medical handovers was seen in those hospitals with high protocol adherence and that  
31 brought much attention to implementation. We believe that future interventions should continue to  
32 create awareness of the importance of timely handovers and we hope that our study contributes to  
33 this, stimulating hospitals to further structure and improve their discharge process.  
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11 collection.  
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23 *Data sharing statement:* No additional data are available.  
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**Table 1.** Baseline characteristics

Variable	Overall (N=2091)	Pre-intervention (N=1039)	Post-intervention (N=1052)
<b>Age in years, mean (SD)<sup>a</sup></b>	68.07 (16.57)	67.66 (16.70)	68.48 (16.45)
<b>Male, No. (%)</b>	971 (46.4)	493 (47.4)	478 (45.4)
<b>Living arrangements before admission, No.(%)</b>			
Independent	1814 (86.7)	883 (84.9)	931 (88.5)
Nursing home	49 (2.3)	27 (2.6)	22 (2.1)
Senior residence/Assisted living	168 (8.1)	91 (8.8)	77 (7.3)
Missing	60 (2.9)	38 (3.7)	22 (2.1)
<b>Marital status, No. (%)</b>			
Married or living together	1125 (53.8)	556 (53.5)	569 (54.1)
Single or divorced	456 (21.8)	212 (20.4)	244 (23.2)
Widow/widower	435 (20.8)	224 (21.6)	211 (20.1)
Missing	75 (3.6)	47 (4.5)	28 (2.7)
<b>Charlson Comorbidity Index<sup>b</sup> (mean, SD<sup>a</sup>)</b>	2.05 (2.05)	2.10 (2.08)	2.01 (2.03)
<b>Polypharmacy, No. (%)<sup>c, d, e</sup></b>	1247 (59.6)	586 (56.4)	661 (62.8)
Missing	12 (.6)	8 (.8)	4 (.4)
<b>Hospitalization in past 6 months, No. (%)</b>	705 (33.7)	339 (32.6)	336 (34.8)
<b>Acute hospitalization, No. (%)<sup>c, f</sup></b>	73.0 (73.0)	725 (69.8)	801 (76.1)
<b>Admission ward, internal medicine No. (%)</b>	1051 (50.3)	524 (50.4)	527 (50.1)
<b>Discharge destination, No. (%)</b>			
Home	1551 (74.2)	770 (74.1)	781 (74.2)
Other health care setting, of which	482 (23.1)	238 (23.0)	244 (23.2)
Rehabilitation center	268 (12.8)	120 (11.5)	148 (14.1)
Nursing home	158 (7.6)	80 (7.7)	78 (7.4)
Assisted living	34 (1.6)	26 (2.5)	8 (0.8)
Other hospital	22 (1.1)	12 (1.2)	10 (1.0)
Missing	58 (2.8)	31 (3.0)	27 (2.6)

<sup>a</sup> Standard Deviation, <sup>b</sup> Range of 0 to 31, with a higher score indicating more or more severe comorbidity<sup>33</sup>, <sup>c</sup> Use of 5 or more different medications, <sup>d</sup> Chi-Square, <sup>e</sup> P-value = 0.004, <sup>f</sup> P-value = 0.001

**Table 2.** Interrupted time series analysis; medical and nursing handovers

	<i>Medical handovers &lt;24 hrs after discharge (%)<sup>a</sup></i>			<i>Time between discharge and medical letter (days)<sup>b</sup></i>			<i>Nursing handovers &lt;24 hrs after discharge (%)<sup>c</sup></i>		
	$\beta$ (SE)	95% CI	p-value	$\beta$ (SE)	95% CI	p-value	$\beta$ (SE)	95% CI	p-value
Intercept	17.51 (3.79)	10.08 to 24.93	<0.01	7.20 (0.29)	6.63 to 7.76	<0.01	91.85 (2.71)	86.53 to 97.16	<0.01
Trend pre-intervention ( $\beta_1$ )	1.49 (0.97)	-0.42 to 3.40	0.16	-0.30 (0.07)	-0.45 to -0.16	<0.01	0.28 (0.70)	-1.09 to 1.64	0.70
Level change directly after intervention ( $\beta_2$ )	6.43 (10.13)	-13.43 to 26.28	0.54	-0.62 (0.74)	-2.07 to 0.84	0.43	6.32 (7.25)	-7.89 to 20.53	0.41
Trend differences ( $\beta_3$ )	-0.94 (1.38)	-3.64 to 1.75	0.51	0.05 (0.10)	-0.14 to 0.25	0.61	-0.81 (0.99)	-2.74 to 1.12	0.43
	Absolute effect directly after intervention: -0.17%			Absolute effect directly after intervention: -0.25 days			Absolute effect directly after intervention: 0.62%		

$\beta_1$  estimates the pre-intervention trend.

$\beta_2$  estimates the difference between the observed level just after the intervention started and that predicted by the pre-intervention trend.

$\beta_3$  estimates the difference in trend between the pre-intervention and post-intervention period.

SE: Standard Error, CI: Confidence Interval

<sup>a</sup> Correction for autocorrelation did not provide a better model compared to the presented model (AIC 74.17 versus 72.88,  $p=0.40$ ), nor did correction for potential confounders ('polypharmacy' and 'acute admission') (AIC 74.98 versus 72.88,  $p=0.39$ ). All models led to results with similar estimates and identical interpretation.

<sup>b</sup> The results are adjusted for autocorrelation, but not for potential confounders. Correction for autocorrelation (AR1) provided a better model compared to the presented model (AIC 21.52 versus 25.72,  $p=0.01$ ). Correction for potential confounders ('polypharmacy' and 'acute admission') did not provide a better model compared to the presented model (AIC 29.23 versus 25.72,  $p=0.78$ ). Correction for autocorrelation (AR1) changed  $\beta_1$  into a significant result. Correction for potential confounders did not alter the results.

<sup>c</sup> Correction for autocorrelation did not provide a better model compared to the presented model (AIC 66.05 versus 59.13,  $p=0.02$ ), nor did correction for potential confounders ('polypharmacy' and 'acute admission') (AIC 59.03 versus 59.13,  $p=0.13$ ). All models led to results with similar estimates and identical interpretation.

**Figure 1. Pyramid for postdischarge care**

A structured discharge process such as the TIP procedure should form the basis for every patient. For patients discharged with postdischarge care (20-25%), nursing handovers should be set up within 48h after admission and be sent within 24h postdischarge. Complex patients with a high readmission risk (10%) require a (nurse) case manager or transitional care in the transition from hospital to home.

**Figure 2.**

**Panel A** The number of medical handovers sent within 24 hours.

**Panel B** median time in days between discharge and the medical handovers.

**Figure 3. Hospital differences based on implementation score.**

The inter-hospital differences in rates of medical handovers being sent within 24h in the pre- and post-intervention based on the extent of implementation and used implementation strategies. Group 1 received >30 feedback implementation points, group 2 received 20-30 implementation points, group 3 received <20 points.

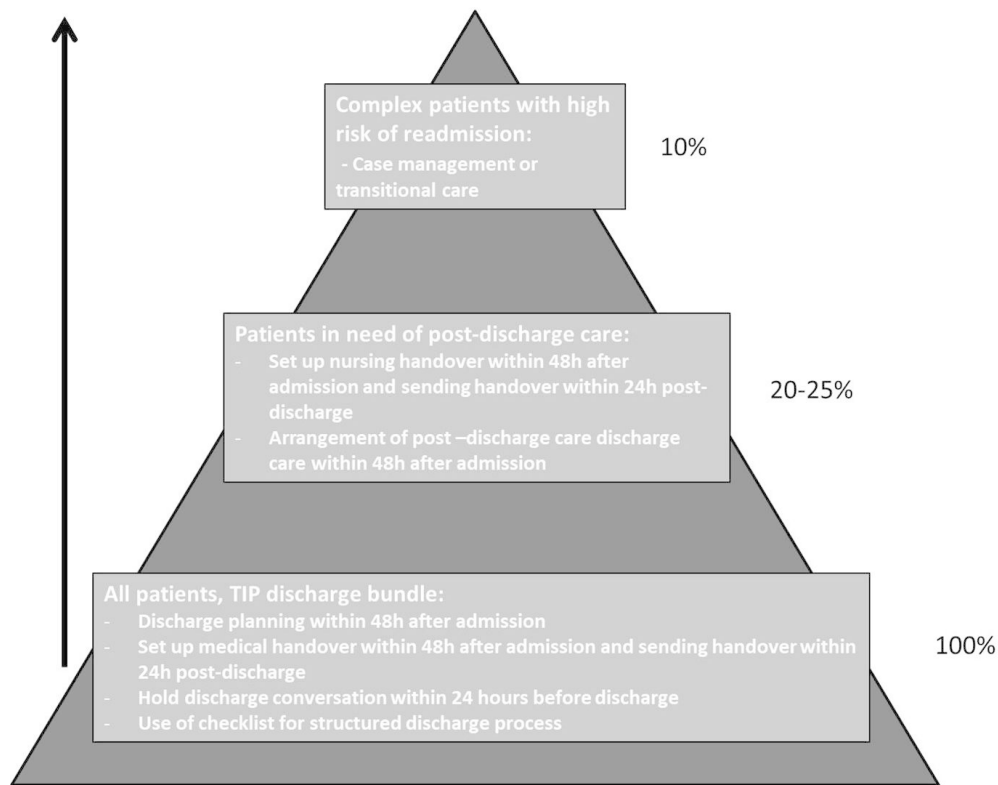


Figure 1. Pyramid for post-discharge care A structured discharge process such as the TIP procedure should form the basis for every patient. For patients discharged with post-discharge care (20-25%), nursing handovers should be set up within 48h after admission and be sent within 24h post-discharge. Complex patients with a high readmission risk (10%) require a (nurse) case manager or transitional care in the transition from hospital to home.

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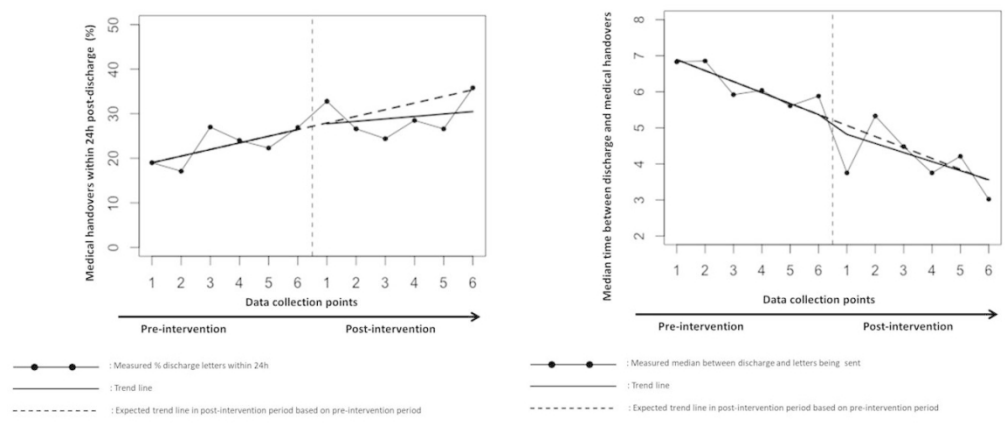


Figure 2.  
 Panel A The number of medical handovers sent within 24 hours.  
 Panel B median time in days between discharge and the medical handovers.

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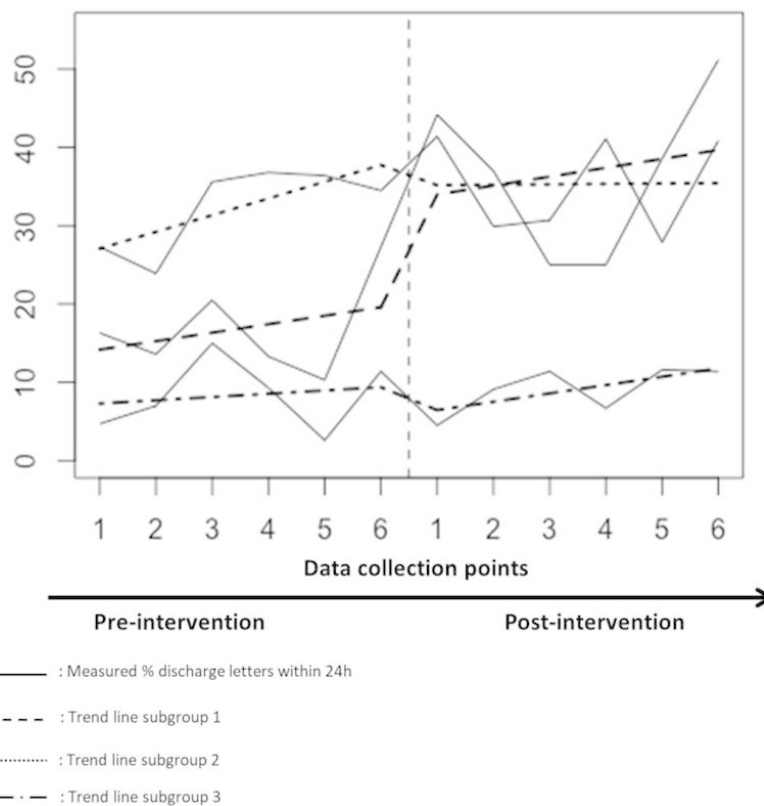


Figure 3. Hospital differences based on implementation score. The inter-hospital differences in rates of medical discharge letters being sent within 24h in the pre- and post-intervention based on the extent of implementation and used implementation strategies. Group 1 received >30 feedback implementation points, group 2 received 20-30 implementation points, group 3 received <20 points.

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**Supplement Table 1.** Adherence to the Intervention Protocol

	Hospital 1	Hospital 2	Hospital 3	Hospital 4	Hospital 5	Hospital 6	Hospital 7	Hospital 8
Pre-intervention	Sep '15 - Feb '16	Oct '15 - March '16	Jan '16 - June '16	Dec '15 - May '16	March '16 – Aug '16	April '16 – Sep '16	May '16 – Oct '16	April '16 – Sep '16
Implementation	March '16 - April '16	April '16 - May '16	July '16 - Aug '16	June '16 - July '16	Sep '16 - Oct '16	Oct '16 - Nov '16	Nov '16 - Dec '16	Oct '16 - Nov '16
Post-intervention	May '16 – Oct '16	June '16 - Nov '16	Sep '16 – Feb '17	Aug '16 - Jan '16	Nov '16 – April '17	Dec '16 – May '17	Jan '17 – June '17	Dec '16 – May '17
<b>Leadership and education of project leaders</b>								
Who were present at the kick off meeting February, 2016?	Hospital president; local project leader; 2 team leaders (nurses); 2 physicians; nurse; pharmacists	Local project leader; geriatrician; head of the liaison department; physician	2 local project leaders; head of the liaison department	Chief of staff; local project leader; team leader surgery ward (nurse); head of the liaison department	Local project leader; head of the liaison department; manager patient logistics; 2 team leaders (nurses)	2 local project leaders	Local project leader	Local project leader; senior researcher transitional care; medical specialist,
Who were present at the first feedback session?	Project leader; head of the liaison department	Project leader; pharmacist; communication assistant	2 local project leaders; liaison nurse	Project leader; liaison nurse; nurse geriatrics	Local project leader	2 local project leaders	-	2 project leaders
Who were present at the second feedback session?	Project leader	Project leader	2 project leaders	-	Project leader	-	Project leader	2 project leaders
<i>Implementation points</i>	10	8	8	7	7	4	2	7
<b>Project group</b>								
Was there a local TIP project group, and who participated?	Yes, project leader; 2 senior nurses of participating wards, management assistant	Yes, project leader; geriatrician; head liaison department, physician; pharmacist; communication assistant; manager Security & Services	Yes, 2 project leaders; 2 residents; 2 medical specialists; nurse; liaison nurse; pharmacist; manager	Yes, chief of staff; project leader; 2 team leaders (nurses); head liaison department; orthopedist	Yes, project leader; head liaison department; 2 medical specialists, geriatrician	No	No	Yes, local project leader; 3 medical specialists; 2 residents, manager quality and safety; manager process optimization; medical director
How often did the local project group meet? 1 point per meeting	Monthly for 2 months, during pilot period every week (2 months).	Every five weeks during pre-intervention and pilot period	2 times, before pilot period.	Every two weeks during pre-intervention period	Every six weeks, during pre-intervention and pilot period	-	-	Monthly during pre-intervention, pilot period and first two months of post-



								intervention period
<i>Implementation points</i>	10	12	10	18	10	0	0	17
<b>Implementation of TIP elements</b>								
Was it policy to set a discharge date within 48h after admission?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Was the planned discharge date communicated to patients?	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Was it policy to start with arrangement of required post-discharge care within 48h after admission?	No, liaison nurse has to wait for final discharge date	No, liaison nurse has to wait for final discharge date	Yes	Yes	No, liaison department is overloaded	Yes	No, liaison nurse has to wait for final discharge date	Yes
Was it policy to set up patient handovers within 48h after admission?	No	No	No	No	No	No	No	No
Did physicians hold discharge conversations, using a checklist during the pilot period?	No	No	No	No	No	No	No	No
Does the nurse holds a discharge conversation, using a checklist?	Yes	No	Yes	Yes	Yes	No	Yes	Yes
Was the patient discharge letter implemented?	Yes, but only for some diagnosis at internal medicine ward.	No	No	No	No	Yes, but only at internal medicine ward for frail older patients.	No	No, a discharge summary was implemented instead.
<i>Implementation points</i>	3.5	2	4	4	3	2.5	3	4.5
<b>Education of physicians and nurses</b>								

1	How were physicians and nurses informed about the TIP and how often?	Kick-off meeting at participating wards; during morning report; working instructions were sent by email to all physicians	Kick-off meeting; meeting at participating wards; E-learning; 1 feedback meeting	During morning reports; project leader informed every physician separately; intranet; email	During morning reports; intranet; email; posters & pocket cards; and project leaders went to participating wards to inform physicians and nurses	Email and project leader went to participating wards	Kick-off meeting, during several morning reports	Physicians were not educated with regard to the intervention	During several morning report; email; project leaders went to participating wards to inform physicians and nurses; medical specialists from project group informed physicians in person									
2	Did physicians and/or nurses receive feedback with regard to their discharge letters and if yes, how often?	No	No	No	No	No	Only for nurses	No	Yes, daily on internal medicine and monthly on surgery ward, via email.									
3	<i>Implementation points</i>	3	4	4	5	2	2.5	0	5									
4	<b>Total implementation points</b>	<b>26.5</b>	<b>26</b>	<b>26</b>	<b>34</b>	<b>22</b>	<b>9</b>	<b>5</b>	<b>33.5</b>									
5	<b>Pre-intervention vs. post-intervention period scores</b>																	
6	<b>Pre-intervention period</b>																	
7	median	% letters within 24h	8.15	9.0	0.90	47.3	6.71	23.5	10.48	13.1	0.79	50.0	6.79	9.2	14.21	7.6	5.83	20.9
8	<b>Post-intervention</b>																	
9	median	% letters within 24h	9.08	19.5	1.0	48.5	5.48	24.2	5.79	19.7	0.29	49.6	7.98	16.7	22.44	1.5	0.83	53.8

**Revised Standards for Quality Improvement Reporting Excellence (SQUIRE 2.0)  
September 15, 2015**

<b>Text Section and Item Name</b>	<b>Section or Item Description</b>
<b>Notes to authors</b>	<ul style="list-style-type: none"> <li>• The SQUIRE guidelines provide a framework for reporting new knowledge about how to improve healthcare</li> <li>• The SQUIRE guidelines are intended for reports that describe <a href="#">system</a> level work to improve the quality, safety, and value of healthcare, and used methods to establish that observed outcomes were due to the <a href="#">intervention(s)</a>.</li> <li>• A range of approaches exists for improving healthcare. SQUIRE may be adapted for reporting any of these.</li> <li>• Authors should consider every SQUIRE item, but it may be inappropriate or unnecessary to include every SQUIRE element in a particular manuscript.</li> <li>• The SQUIRE Glossary contains definitions of many of the key words in SQUIRE.</li> <li>• The Explanation and Elaboration document provides specific examples of well-written SQUIRE items, and an in-depth explanation of each item.</li> <li>• Please cite SQUIRE when it is used to write a manuscript.</li> </ul>
<b>Title and Abstract</b>	
<b>1. Title</b>	Indicate that the manuscript concerns an <a href="#">initiative</a> to improve healthcare (broadly defined to include the quality, safety, effectiveness, patient-centeredness, timeliness, cost, efficiency, and equity of healthcare)
<b>2. Abstract</b>	<ol style="list-style-type: none"> <li>a. Provide adequate information to aid in searching and indexing</li> <li>b. Summarize all key information from various sections of the text using the abstract format of the intended publication or a structured summary such as: background, local <a href="#">problem</a>, methods, interventions, results, conclusions</li> </ol>
<b>Introduction</b>	<i>Why did you start?</i>
<b>3. <a href="#">Problem Description</a></b>	Nature and significance of the local <a href="#">problem</a>
<b>4. Available knowledge</b>	Summary of what is currently known about the <a href="#">problem</a> , including relevant previous studies

1 2 3 4 5 6 7	<b>5. <u>Rationale</u></b>	Informal or formal frameworks, models, concepts, and/or <a href="#">theories</a> used to explain the <a href="#">problem</a> , any reasons or <a href="#">assumptions</a> that were used to develop the <a href="#">intervention(s)</a> , and reasons why the <a href="#">intervention(s)</a> was expected to work
8 9	<b>6. Specific aims</b>	Purpose of the project and of this report
10 11	<b>Methods</b>	<i>What did you do?</i>
12 13	<b>7. <u>Context</u></b>	Contextual elements considered important at the outset of introducing the <a href="#">intervention(s)</a>
14 15 16 17	<b>8. <u>Intervention(s)</u></b>	a. Description of the <a href="#">intervention(s)</a> in sufficient detail that others could reproduce it b. Specifics of the team involved in the work
18 19 20 21	<b>9. Study of the Intervention(s)</b>	a. Approach chosen for assessing the impact of the <a href="#">intervention(s)</a> b. Approach used to establish whether the observed outcomes were due to the <a href="#">intervention(s)</a>
22 23 24 25 26 27 28	<b>10. Measures</b>	a. Measures chosen for studying <a href="#">processes</a> and outcomes of the <a href="#">intervention(s)</a> , including rationale for choosing them, their operational definitions, and their validity and reliability b. Description of the approach to the ongoing assessment of contextual elements that contributed to the success, failure, efficiency, and cost c. Methods employed for assessing completeness and accuracy of data
29 30 31 32 33	<b>11. Analysis</b>	a. Qualitative and quantitative methods used to draw <a href="#">inferences</a> from the data b. Methods for understanding variation within the data, including the effects of time as a variable
34 35 36 37	<b>12. Ethical Considerations</b>	<a href="#">Ethical aspects</a> of implementing and studying the <a href="#">intervention(s)</a> and how they were addressed, including, but not limited to, formal ethics review and potential conflict(s) of interest
38 39	<b>Results</b>	<i>What did you find?</i>
40 41 42 43 44 45 46 47 48 49 50	<b>13. Results</b>	a. Initial steps of the <a href="#">intervention(s)</a> and their evolution over time (e.g., time-line diagram, flow chart, or table), including modifications made to the intervention during the project b. Details of the <a href="#">process</a> measures and outcome c. Contextual elements that interacted with the <a href="#">intervention(s)</a> d. Observed associations between outcomes, interventions, and relevant contextual elements e. Unintended consequences such as unexpected benefits, problems, failures, or costs associated with the <a href="#">intervention(s)</a> . f. Details about missing data
51 52	<b>Discussion</b>	<i>What does it mean?</i>
53 54 55 56 57 58 59 60	<b>14. Summary</b>	a. Key findings, including relevance to the <a href="#">rationale</a> and specific aims b. Particular strengths of the project

<b>15. Interpretation</b>	<ul style="list-style-type: none"> <li>a. Nature of the association between the <a href="#">intervention(s)</a> and the outcomes</li> <li>b. Comparison of results with findings from other publications</li> <li>c. Impact of the project on people and <a href="#">systems</a></li> <li>d. Reasons for any differences between observed and anticipated outcomes, including the influence of <a href="#">context</a></li> <li>e. Costs and strategic trade-offs, including <a href="#">opportunity costs</a></li> </ul>
<b>16. Limitations</b>	<ul style="list-style-type: none"> <li>a. Limits to the <a href="#">generalizability</a> of the work</li> <li>b. Factors that might have limited <a href="#">internal validity</a> such as confounding, bias, or imprecision in the design, methods, measurement, or analysis</li> <li>c. Efforts made to minimize and adjust for limitations</li> </ul>
<b>17. Conclusions</b>	<ul style="list-style-type: none"> <li>a. Usefulness of the work</li> <li>b. Sustainability</li> <li>c. Potential for spread to other <a href="#">contexts</a></li> <li>d. Implications for practice and for further study in the field</li> <li>e. Suggested next steps</li> </ul>
<b>Other information</b>	
<b>18. Funding</b>	Sources of funding that supported this work. Role, if any, of the funding organization in the design, implementation, interpretation, and reporting

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3 **Table 2. Glossary of key terms used in SQUIRE 2.0. This Glossary provides the intended**  
4 **meaning of selected words and phrases as they are used in the SQUIRE 2.0 Guidelines. They**  
5 **may, and often do, have different meanings in other disciplines, situations, and settings.**  
6

### 7 **Assumptions**

8 Reasons for choosing the activities and tools used to bring about changes in healthcare services at  
9 the [system](#) level.  
10  
11

### 12 **Context**

13 Physical and sociocultural makeup of the local environment (for example, external environmental  
14 factors, organizational dynamics, collaboration, resources, leadership, and the like), and the  
15 interpretation of these factors (“sense-making”) by the healthcare delivery professionals, patients,  
16 and caregivers that can affect the effectiveness and [generalizability](#) of [intervention\(s\)](#).  
17  
18

### 19 **Ethical aspects**

20 The value of [system](#)-level [initiatives](#) relative to their potential for harm, burden, and cost to the  
21 stakeholders. Potential harms particularly associated with efforts to improve the quality, safety, and  
22 value of healthcare services include [opportunity costs](#), invasion of privacy, and staff distress  
23 resulting from disclosure of poor performance.  
24  
25

### 26 **Generalizability**

27 The likelihood that the [intervention\(s\)](#) in a particular report would produce similar results in other  
28 settings, situations, or environments (also referred to as external validity).  
29  
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### 31 **Healthcare improvement**

32 Any systematic effort intended to raise the quality, safety, and value of healthcare services, usually  
33 done at the [system](#) level. We encourage the use of this phrase rather than “quality improvement,”  
34 which often refers to more narrowly defined approaches.  
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### 37 **Inferences**

38 The meaning of findings or data, as interpreted by the stakeholders in healthcare services –  
39 improvers, healthcare delivery professionals, and/or patients and families  
40  
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### 42 **Initiative**

43 A broad term that can refer to organization-wide programs, narrowly focused projects, or the details  
44 of specific interventions (for example, planning, execution, and assessment)  
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### 47 **Internal validity**

48 Demonstrable, credible evidence for efficacy (meaningful impact or change) resulting from  
49 introduction of a specific intervention into a particular healthcare [system](#).  
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### 52 **Intervention(s)**

53 The specific activities and tools introduced into a healthcare [system](#) with the aim of changing its  
54 performance for the better. Complete description of an intervention includes its inputs, internal  
55 activities, and outputs (in the form of a logic model, for example), and the mechanism(s) by which  
56 these components are expected to produce changes in a [system's](#) performance.  
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### 59 **Opportunity costs**

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3 Loss of the ability to perform other tasks or meet other responsibilities resulting from the diversion  
4 of resources needed to introduce, test, or sustain a particular [improvement](#) initiative  
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### 7 **Problem**

8 Meaningful disruption, failure, inadequacy, distress, confusion or other dysfunction in a healthcare  
9 service delivery [system](#) that adversely affects patients, staff, or the [system](#) as a whole, or that  
10 prevents care from reaching its full potential  
11

### 12 **Process**

13 The routines and other activities through which healthcare services are delivered  
14  
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### 16 **Rationale**

17 Explanation of why particular [intervention\(s\)](#) were chosen and why it was expected to work, be  
18 sustainable, and be replicable elsewhere.  
19

### 20 **Systems**

21 The interrelated structures, people, [processes](#), and activities that together create healthcare services  
22 for and with individual patients and populations. For example, systems exist from the personal self-  
23 care system of a patient, to the individual provider-patient dyad system, to the microsystem, to the  
24 macrosystem, and all the way to the market/social/insurance system. These levels are nested within  
25 each other.  
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### 28 **Theory or theories**

29 Any “reason-giving” account that asserts causal relationships between variables (causal theory) or  
30 that makes sense of an otherwise obscure [process](#) or situation (explanatory theory). Theories come  
31 in many forms, and serve different purposes in the phases of [improvement](#) work. It is important to  
32 be explicit and well-founded about any informal and formal theory (or theories) that are used.  
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# BMJ Open

## A safe handover for every patient: an interrupted time series analysis to test the effect of a structured discharge bundle in Dutch hospitals

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Manuscripts



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3 **A safe handover for every patient: an interrupted time series analysis to test the effect of a**  
4 **structured discharge bundle in Dutch hospitals**  
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47 *Key words:* Discharge Bundle, Patient Handovers, Patient Safety, Interrupted Time Series, Quality  
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54 Word count: 3214  
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## Abstract

**Objective** Patient handovers are often delayed, patients are hardly involved in their discharge process and hospital-wide standardized discharge procedures are lacking. The aim of this study was to implement a structured discharge bundle and to test the effect on timeliness of medical and nursing handovers, length of hospital stay (LOS) and unplanned readmissions.

**Design** Interrupted time series with six pre-intervention and six post-intervention data collection points (September 2015 through June 2017).

**Setting** Internal medicine and surgical wards.

**Participants** Patients ( $\geq 18$  years) admitted for more than 48h to surgical or internal medicine wards.

**Intervention** The Transfer Intervention Procedure (TIP), containing four elements: planning the discharge date within 48h post-admission, arrangements for postdischarge care, preparing handovers and personalized patient discharge letter; and a discharge conversation 12-24h before discharge.

**Outcome measures** The number of medical and nursing handovers sent within 24h. Secondary outcomes were median time between discharge and medical handovers, LOS and unplanned readmissions.

**Results** Pre-intervention 1039 and post-intervention 1052 patient records were reviewed. No significant change was observed in the number of medical and nursing handovers sent within 24h. The median (interquartile range) time between discharge and medical handovers decreased from 6.15 (0.96-15.96) to 4.08 (0.33-13.67) days, but no significant difference was found. No intervention-effect was observed for LOS and readmission. In subgroup analyses, a reduction of 5.6 days in the median time between discharge and medical handovers was observed in hospitals with high protocol adherence and much attention for implementation.

**Conclusion** Implementation of a structured discharge bundle did not lead to improved timeliness of patient handovers. However, large inter-hospital variation was observed and an intervention effect

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3 on the median time between discharge and medical handovers was seen in hospitals with high  
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5 protocol adherence. Future interventions should continue to create awareness of the importance of  
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7 timely handovers.  
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12 **Trial Registration:** Dutch Trial Registry: NTR5951  
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### 15 16 **Strengths and limitations of this study**

- 17  
18 • The study design, i.e. interrupted time series analysis, provides a strong quasi-experimental  
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20 design to evaluate the impact of an intervention aimed at quality improvement.  
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24 • The study design, i.e. interrupted time series analysis, provided valuable information on pre-  
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26 intervention trends, which strengthens the results.  
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29 • Sensitivity analysis provided important insight into the inter-hospital variation and  
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31 differences in intervention effects among hospitals.  
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34 • Only the date of sending patient handovers were recorded. Knowing whether the next care  
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36 provider received information would have been informative.  
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39 • It was not possible to evaluate percentages of compliance with the study protocol and the  
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41 process evaluation with the project leaders might have been an overestimation.  
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## Introduction

As hospital stays have become shorter and full recovery often takes place at home,<sup>1</sup> a safe transition from hospital to home or nursing home has become more and more important. Besides, a rising number of older chronically ill patients who move within the health care system, requires continuity of care<sup>2 3</sup>. However, transitions from hospital to primary care settings are still considered a high-risk process. Patients are discharged with little coordination or follow-up and are hardly involved in their own discharge process<sup>4 5</sup>.

Inadequate transitions may have serious implications for patient safety and quality of care. Postdischarge adverse events such as medication errors, can be the consequence of insufficient or lacking communication between hospital and primary care providers, thereby contributing to higher resource use and unplanned readmission rates<sup>6-11</sup>. In fact, unplanned readmission rates in the first month postdischarge are as high as 20%<sup>12</sup> and a recent study shows that half of them are deemed preventable<sup>11</sup>.

The root of a safe transition from hospital to home or nursing home is a timely transfer of the medical handover, that is a letter containing accurate medical discharge information for the next care provider<sup>8 13</sup>. The general practitioner (GP) can only take over responsibility for a patient safely, when receiving a medical handover containing accurate information on, e.g., medications, and follow-up<sup>13</sup>. Nonetheless, a review of Kripalani et al. showed that medical handovers are often not available, lack important information or are not sent in a timely manner<sup>8</sup>. Also, a more recent study performed in 20 Dutch hospitals showed that in 10% of cases medical handover were missing and the remainder was on average sent after one week,<sup>14</sup> even though unplanned readmissions most frequently occur within the first week postdischarge<sup>15</sup>.

Previous studies that aimed to improve patient handovers, mainly focused on specific high risk populations and targeted patient-related factors<sup>16-18</sup>. Although such interventions on individualized discharge planning or transitional care have been effective in reducing readmission<sup>16 17</sup>

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3 and postdischarge mortality rates,<sup>18-20</sup> organizational factors that form the basis of a safe handover  
4 should also be optimally arranged<sup>13 21</sup>. In fact, in order to ensure patient safety and continuity of care,  
5 early discharge planning, a structured discharge process and timely handovers might be essential<sup>13 21</sup>  
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<sup>22</sup>. Besides, given that patients are often unprepared at time of discharge and uncertainties about aspects such as treatment or medication may exist,<sup>5</sup> patient education, e.g., in terms of a proper discharge conversation, should also be an important aspect of the discharge process<sup>6 7</sup>.

The aim of this study was, therefore, to implement a structured discharge process, the Transfer Intervention Procedure (TIP), in eight hospitals. The TIP contains four elements: planning the discharge date within 48h after admission, arrangements for required postdischarge care, preparing medical, medication, and nursing handovers and a personalized discharge letter for the patient (PPDL) within 48h after admission; and holding a discharge conversation 12 to 24h before discharge. We tested whether the TIP improved timeliness of medical and nursing handovers and investigated the effect of the TIP procedure on length of hospital stay and unplanned readmissions within 30-days postdischarge.

## Methods

### *Study design and setting*

We evaluated the implementation of the TIP discharge bundle in an interrupted time series (ITS), which is the strongest design when a randomized controlled trial is not feasible<sup>23 24</sup>. The trial protocol<sup>25</sup> was based on the recommendations for ITS studies,<sup>23</sup> and we adhered to the SQUIRE guidelines for quality improvement reporting<sup>26</sup>. The current study was part of a large national program, initiated by the Dutch Ministry of Health, Welfare, and Sport (abbreviated in Dutch: VWS): 'Addressing Waste in Health Care'. This program was set up in order to reduce inefficiencies in the provision of health care. As part of this program, a TIP study group was established, comprising a study coordinator, two supervisors, one clinical epidemiologist, a policy officer from the Ministry of

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3 VWS and local project leaders from the eight participating hospitals (one university and seven  
4 regional teaching throughout the Netherlands) that implemented the TIP bundle at one of their  
5 surgical and one of their internal medicine wards.  
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10 Within an interrupted time series, repeated observations are collected over time and divided  
11 into two segments, one before and one after implementation. Therefore, at six pre-intervention data  
12 collection points, measurements were conducted before implementation of the TIP and at six post-  
13 intervention data collection points measurements were conducted after implementation. During the  
14 implementation period of two months no measurements were conducted. February 2016, a kick off  
15 meeting was held. Between March 2016 and November 2016, hospitals started with implementation.  
16 Data collection started September 2015 and ended June 2017 (Supplement Table 1). All patients  
17 (aged  $\geq 18$  years) admitted for more than 48h were eligible for inclusion. The Medical Ethics Research  
18 Committee (METC) confirmed that the Medical Research Involving Human Subjects Act did not apply  
19 to this research project and official approval was not required. Since the study involved a quality  
20 improvement intervention with negligible risk of harming patients, individual informed consent was  
21 waived for all participating hospitals by the legal department research support of the Amsterdam  
22 UMC, location AMC. This trial was registered with the Dutch Trial Registry number NTR5951.  
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#### 41 *The discharge process in the Netherlands*

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43 In the Netherlands, primary care standards are relatively high and basically every person has a  
44 general practitioner (GP). When a person is hospitalized, responsibility is taken over from the GP by  
45 the medical specialist. After discharge, patient care becomes the responsibility of the GP again. It is  
46 policy for hospitals to provide patient handovers to the GP. However, there are no clear guidelines  
47 for hospitals how to arrange their discharge process. The Dutch healthcare inspectorate,<sup>27</sup> indicated  
48 that standardized discharge processes are lacking and errors that occur during handovers are often  
49 resolved informally.  
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3 After discharge from the hospital, the hospital physician sends a medical handover to the  
4 primary care provider for every patient (e.g., nursing home physician or the GP). Medical handovers  
5 include information on the reason for admission, diagnosis, comorbidity, the course of admission,  
6 medical examinations, treatment, medication, the health status of the patient at discharge, and  
7 instructions on follow-up<sup>28</sup>. Nursing handovers are only provided when the patient is discharged to a  
8 nursing home or with postdischarge care at the patient's own home. Nursing handovers include  
9 information on the care provided during hospitalization, current nursing care problems, the reason  
10 why (nursing) home care is initiated, and the intended outcomes of the care that will be provided<sup>29</sup>.  
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### 23 *Intervention*

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25 Figure 1 (adapted from van Seben et al.<sup>30</sup>) illustrates how the TIP bundle forms the basis of a safe  
26 handover from hospital to primary care for every patient, and if applicable, for patients discharged  
27 with postdischarge care (e.g., home care or a nursing home) or for complex patients who require a  
28 case manager or transitional care. As described in two previous studies,<sup>25 31</sup> the TIP bundle was  
29 developed using input from focus group meetings with professionals, patient surveys and literature.  
30 The TIP discharge bundle consists of four elements: 1) planning the discharge date within 48h after  
31 admission and communication of the discharge date with the patient, 2) starting with arrangements  
32 for required postdischarge care within 48h after admission; 3) preparing patient handovers (medical,  
33 medication, nurse) and personalized patient discharge letter (PPDL<sup>32</sup>) within 48h after admission, 4)  
34 planning a discharge conversation with the patient to explain information from the PPDL 12-24h  
35 before discharge. The PPDL is a standardized document, containing understandable information for  
36 the patient on the reason for admission, hospital treatment, course of the disease, possible sustained  
37 consequences or complications, and information on medication. We constructed checklists based on  
38 the TIP, which served as remembering tool for nurses and physicians in the electronic system or on  
39 pocket cards.  
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### *Patient and public Involvement*

Our research question was developed from the perspective that patients are discharged with little coordination or follow-up and that they are often unprepared at time of discharge<sup>4 5</sup>. Patients were involved as participants in the construction of the TIP discharge bundle, which was based on, among others, patient satisfaction surveys<sup>25 31</sup>. Further, in a previous study in which the PPDL was developed and implemented, patient satisfaction with the PPDL was also assessed<sup>32</sup>.

### *Protocol adherence*

To enhance intervention fidelity and protocol adherence in the different hospitals, regular meetings were held with the TIP study group to report results and provide feedback, to discuss implementation, share experience and learn from each other's practices. A process evaluation was conducted with the project leaders to investigate protocol adherence, implementation strategies and attention paid to implementation. Elements that were considered included leadership and education of project leaders, projects group, extent of implementation of the discharge bundle, and education of physicians and nurses. Feedback points were awarded for all elements and for the extent to which the hospital complied to a certain element, e.g., for every person present at the kick off meeting or for every project meeting that was held. When a hospital partly complied to an element, e.g. automatically generated discharge summaries were provided to the patient instead of a PPDL or feedback on timely handovers was only provided to nurses, 0.5 feedback points were awarded. It was not possible to evaluate percentages of compliance with discharge conversations, planning discharge dates and arrangement of postdischarge care within 48h since these aspects were not reported in patient records. Hospital policies regarding these elements were assessed.

### *Outcome measures*



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3 Our primary outcome was the number of medical and nursing handovers sent within 24h. This time-  
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5 frame was based on a report of the Dutch healthcare inspectorate (In Dutch: Inspectie voor de  
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7 Gezondheidszorg en Jeugd (IGJ)) on the discharge process and handovers, in which it is stated that  
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9 accurate information needs to be available as quick as possible, but certainly within 24h, for the next  
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11 care provider<sup>27</sup>. Medical handovers also include medication handovers and we considered the time  
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13 that these handovers were sent to the GP. The median time between discharge and the medical  
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15 handover was considered as secondary outcome. Further, secondary outcomes were length of  
16  
17 hospital stay (LOS) and rates of unplanned readmission within 30 days.  
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### 23 *Baseline data collection*

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25 Data regarding patient characteristics included: demographics, admission ward and medical data (i.e.  
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27 presence of polypharmacy, comorbidity,<sup>33</sup> number of hospitalization in the six months prior to  
28  
29 current hospitalization). Variables were all collected from patient files. All data were reported and  
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31 analyzed anonymously.  
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### 37 *Sample size calculation*

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39 Based on the findings of a previous study<sup>31</sup> we expected to find a reduction of 78% in the time  
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41 between discharge and medical handovers sent. We conducted a power analysis with a number of  
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43 patients based on the number of hospital beds at the participating wards and feasibility with regards  
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45 to data collection, which was set at 11 patients. In a simulation study with 16 wards, each  
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47 contributing 65 patients, we estimated the power to be approximate 91% to demonstrate a  
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49 reduction of 78% in time until sending the medical handover, assuming that the intraclass correlation  
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51 coefficient does not exceed 0.05.  
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### 57 *Statistical analysis*

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3 Descriptive characteristics of patients were calculated using proportions, means and standard  
4 deviations (SD), or medians and interquartile ranges (IQR), as appropriate. Chi-squared analysis and  
5 the Mann Whitney test were used to compare pre-intervention and post-intervention patient  
6 characteristics. Our time series was divided into two segments, one before and one after  
7 implementation of the TIP and we used segmented regression analysis to detect post-intervention  
8 level changes (i.e., an immediate change in the observed outcome after implementation) and  
9 changes in post-intervention trends relative to pre-intervention trends (i.e., a change in slopes of the  
10 regression lines after implementation). A least square regression line was fitted to the two segments  
11 of the continuous time variable. The segmented regression helped us to estimate the change in the  
12 intercept and the slope coefficients between the pre-intervention and post-intervention period using  
13 the following model:  $Y_t = \alpha + \beta_1 \text{time}_t + \beta_2 \text{intervention}_t + \beta_3 \text{time after intervention}_t + \varepsilon_t$ . Since observations  
14 over time are correlated, we explored models with no, a first order autoregressive correlation  
15 between consecutive data collection periods, and longer autocorrelation structures.<sup>24</sup> We used the  
16 Akaike Information Criterion (AIC) as an estimator of the relative quality of a model and we report  
17 the results from the best fitting model. Correction for baseline imbalances as potential confounders  
18 led to results with similar estimates and identical interpretation. Based on the extent of protocol  
19 adherence and the feedback points awarded, subgroup analyses were performed to assess the  
20 intervention effect on the number of medical handovers within 24h and the median time between  
21 discharge and medical handovers. Statistical analyses were performed using SPSS Statistics ©,  
22 version 24.0, and Rstudio, version 1.0.136 (© 2009 – 2016 Rstudion, Inc).

## 50 Results

51  
52 A total of 2091 patient records (1039 pre- and 1052 post-intervention) were reviewed in order to  
53 investigate the effect of the Transfer Intervention Procedure (TIP) on the timeliness of medical and  
54 nursing handovers, length of hospital stay (LOS) and unplanned readmission within 30 days. Overall  
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3 patients had a mean age (SD) of 68.1 (16.6) and 46.4% were male (table 1). There were significant  
4  
5 differences between the pre-, and post-intervention group with regard to polypharmacy and the  
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7 ratio of acute/elective hospitalizations and these variables were considered as potential  
8  
9 confounders. However, correction for these potential confounders did not provide better models  
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11  
12 than the presented models.  
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### 16 *Protocol adherence*

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18 Implementation strategies and protocol adherence are summarized in Supplement Table 1. Based on  
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20 the process evaluation, three subgroups were identified. Subgroup 1 (hospitals 4 and 8), >30  
21  
22 feedback points, paid considerable attention to implementation and there was relatively high  
23  
24 protocol adherence. In subgroup 2 (hospitals 1-3, and 5), 20-30 feedback points, there was relatively  
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26 high protocol adherence but moderate attention to implementation. In subgroup 3 (hospitals 6 and  
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28 7), <10 feedback points, nearly no attention was brought to implementation and there was low  
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30 compliance.  
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### 36 *Medical and nursing handovers*

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38 In the total study population, no intervention effect was found on the percentage of medical  
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40 handovers being sent within 24h after hospital discharge to the GP: 22.7% medical handovers were  
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42 sent within 24h pre-intervention, 29.1% post-intervention and no significant difference was observed  
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44 in the levels and trends between the pre-intervention and post-intervention period. The median  
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46 (interquartile range, IQR) time between discharge and medical handovers decreased from 6.15 (0.96-  
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48 15.96) days, pre-intervention to 4.08 (0.33-13.67) days post-intervention. An absolute effect directly  
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50 after the implementation of the intervention of -0.25 days was found (i.e., de difference in time  
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52 between discharge and medical handovers between the sixth pre-intervention data collection point  
53  
54 and first post-intervention data collection point). We observed no significant difference in the levels  
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3 and trends. The number of nursing handovers sent within 24h postdischarge was 92.8% pre-  
4 intervention and 93.1% post-intervention and no significant difference was observed between levels  
5 and trends. The results are presented in Figure 2 and the parameters estimates are summarized in  
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10 Table 2.

#### 11 12 13 14 *Length of hospital stay and unplanned readmission rates*

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16 No significant decline in the levels and trends between the pre-, and post-intervention was found  
17 with regard to LOS ( $\beta$  0.08, 95% CI -0.12 to 0.29  $p=0.45$ ) and unplanned readmission rates ( $\beta$  1.11,  
18 95% CI -2.55 to 0.33  $p=0.17$ ). Median (IQR) LOS was 8.17 (4.75-15.13) and 8.56 (4.88-15.91) days and  
19 readmissions rates were as high as 11.1% and 12.3% pre-intervention and post-intervention,  
20 respectively. With regard to LOS, the results are adjusted for autocorrelation (AIC 22.64 versus 33.75,  
21  $p=0.01$ ), but not for potential confounders (AIC 43.08 versus 33.75,  $p=0.07$ ). With regard to  
22 unplanned readmission rates, the results are unadjusted for autocorrelation (AIC 57.18 versus 54.45,  
23  $p=0.10$ ) and potential confounders (AIC 57.47 versus 54.45,  $p=0.61$ ).  
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#### 36 37 *Subgroup analysis*

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39 In subgroup 1 (>30 feedback points), an absolute effect of 13.3% more medical handovers sent  
40 within 24h postdischarge was observed but this did not result in significant changes in level or trends  
41 (Figure 3). A reduction of 5.6 days in the median time between discharge and handovers with a  
42 significant change in level directly after the intervention was observed in subgroup 1 ( $\beta$  -5.29, 95% CI  
43 -8.70 to 1.87  $p=0.02$ ). Pre-intervention, group 2 (20-30 feedback points) had the highest rate of  
44 medical handovers sent within 24h and the lowest median time between discharge and medical  
45 handovers but no intervention effect was observed. Both pre- and post-intervention, subgroup 3  
46 (<10 points) had the lowest rates of medical handovers sent within 24h, and the highest median  
47 time. We observed no intervention effect in subgroup 3.  
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## Discussion

In the total study population, a structured discharge bundle, the Transfer Intervention Procedure (TIP), did not lead to improved timeliness of medical and nursing handovers. Although medical handovers were sent faster post-intervention (pre-intervention median 6.15; post-intervention 4.08 days), we were unable to show significant differences in level and trends, both with regard to the median time and the number of medical handovers sent within 24h. However, large inter-hospital variation was observed and a significant intervention effect on the median time between discharge and medical handovers was seen in those hospitals with relatively high protocol adherence and attention for implementation. Rates of nursing handovers sent within 24h were both pre- and post-intervention above 90%. No intervention effect was found for length of hospital stay (LOS) and readmissions.

Extensive research has been conducted to improve patient handovers from hospital to home<sup>7</sup> <sup>16</sup>. Summarizing findings of earlier discharge interventions that aimed to improve coordination of care and communication between hospital and primary care providers, Hesselink et al.,<sup>7</sup> and Kripalani et al.,<sup>8</sup> showed that some studies were able to improve timeliness of medical handovers. These interventions, however, were based on the introduction of fax, email or web-based transfers of information, which is increasingly becoming standard practice in Dutch hospitals. Yet, further improvement may lie in electronic sending systems that support the use of standardized formats that pull information from patient files into (medical) handovers or that send information to the next care provider automatically.

Although a before-after design would probably have led to a significant intervention-effect, the ITS analysis provided valuable information on pre-intervention trends. The observed median time between discharge and sending medical handovers at our first pre-intervention measurement point was consistent with a recent Dutch study<sup>14</sup>, but a trend towards sending handovers faster was

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3 already observed along the pre-intervention period. During the pre-intervention period, no  
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5 interventions were implemented and the TIP was introduced and implemented during a two-month  
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7 implementation period during which no measurements were conducted. However, in the pre-  
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9 intervention period, attention was already brought to the discharge process, e.g. by establishing  
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11 project groups and the kick-off meeting. Although these activities were not intended as  
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13 implementation strategies, in hindsight they might explain why improvements were already  
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15 observed during the pre-intervention period, particularly since education on the importance of the  
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17 intervention is an important aspect of implementation<sup>13 34 35</sup>.

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21 Although positive trends in the pre-intervention period were less pronounced in the  
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23 subgroup analysis, results of the separate analyses support the idea that attention is important.  
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25 Whereas a significant reduction of six days in the median time between discharge and medical  
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27 handovers was observed in hospitals that paid much attention to implementation, no intervention  
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29 effect was observed in hospitals that paid moderate to nearly no attention. It should be noted that  
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31 the hospitals that paid moderate attention had relatively good pre-intervention scores. A smaller  
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33 window for improvement in these hospitals might also explain a lack of intervention effect<sup>36</sup>.

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37 Implementation of the TIP procedure did not reveal a reduction of LOS. Although a possible  
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39 explanation can be low overall compliance with our study protocol, it is also plausible that over the  
40  
41 past years, average LOS has decreased to a minimum<sup>37</sup>. Given current pressure on availability of  
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43 hospital beds, patients are discharged as soon as possible. This may account for inadequate discharge  
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45 processes, since physicians are forced to prioritize acute health care over discharge-related tasks<sup>38 39</sup>.

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48 Given increasingly shorter LOS<sup>37</sup> and the often complex care needs patient face, patient  
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50 preparation should be an important aspect of the discharge process. In fact, the most effective  
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52 discharge interventions seem to have educational components<sup>40</sup>. Unfortunately, given the workload  
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54 among residents, implementation of a personalized patient discharge letter was unsuccessful. E.g.,  
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56 posing the question “do you feel ready to go home”<sup>41</sup> or postdischarge telephone contact,<sup>7</sup> might be  
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3 less time-consuming ways to involve patients. However, to prevent readmissions more effort might  
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5 be necessary. Previous interventions that revealed a reduction in readmission rates, consist of  
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7 individualized discharge planning or continue postdischarge<sup>16 42</sup>. However, we believe that a  
8  
9 structured discharge process such as the TIP should form the basis for a safe handover for every  
10  
11 patient (Figure 1).  
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### 16 *Implications for further research*

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18 Our study shed light on the difficulties that come along with implementation of quality improvement  
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20 collaboratives<sup>43</sup>. Given the positive pre-intervention trends and significant reduction in the median  
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22 time between discharge and medical handovers in hospitals that paid much attention to  
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24 implementation, further improvements may lie in interventions that create more awareness of the  
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26 importance of timely handovers and hospital physicians' crucial role in the provision of continuity of  
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28 care. This might stimulate physicians' intrinsic motivation to provide a structured discharge process  
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30 and thereby timely handovers<sup>7 39</sup>. Furthermore, we might also want to focus on local factors that lead  
31  
32 to insufficient discharge processes. A comprehensive exploration of local barriers for each step in the  
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34 TIP discharge process might be helpful in order to develop tailor made interventions on a local or  
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36 department level to improve the discharge process<sup>44</sup>.  
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### 43 *Limitations*

44  
45 An interrupted time series provides a strong quasi-experimental design to evaluate the impact of an  
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47 intervention aimed at quality improvement. However, this study design also has limitations. First of  
48  
49 all, a positive trend towards sending handovers faster along the pre-intervention period, which was  
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51 probably due to the attention that was already brought to the discharge process before  
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53 implementation of the discharge bundle. In fact, an important limitation of ITS is that it is more  
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55 difficult to determine whether the observed effect is a direct effect of the intervention, in contrast to  
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3 e.g., clustered trials. Second, medical staff was not blinded for the outcome measure, that is timely  
4 discharge letters. Knowing that timeliness of discharge letters was monitored might have altered our  
5 results. However, in most hospitals timeliness of discharge letters was already monitored before we  
6 started with our research project and the effect is likely to be minimal. Third, we only recorded the  
7 date of sending medical handovers. Knowing whether they were received by GPs would also have  
8 provided valuable information. Fourth, we did not look at the content of handovers, while this might  
9 have given us important insights. Lastly, it was not possible to evaluate percentages of protocol  
10 adherence and the process evaluation with the project leaders might have been an overestimation.  
11 However, the process evaluation was in line with the efforts observed during implementation.  
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## 26 **Conclusion**

27 Implementation of a structured discharge bundle, the Transfer Intervention Procedure (TIP), did not  
28 lead to more medical and nursing handovers sent within 24h postdischarge. Large inter-hospital  
29 variation was observed however, and a significant intervention effect on the median time between  
30 discharge and medical handovers was seen in those hospitals with high protocol adherence and that  
31 brought much attention to implementation. We believe that future interventions should continue to  
32 create awareness of the importance of timely handovers and we hope that our study contributes to  
33 this, stimulating hospitals to further structure and improve their discharge process.  
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23 *Data sharing statement:* All data relevant to the study are included in the article or uploaded as  
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25 supplementary information.  
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**Table 1.** Baseline characteristics

Variable	Overall (N=2091)	Pre-intervention (N=1039)	Post-intervention (N=1052)
<b>Age in years, mean (SD)<sup>a</sup></b>	68.07 (16.57)	67.66 (16.70)	68.48 (16.45)
<b>Male, No. (%)</b>	971 (46.4)	493 (47.4)	478 (45.4)
<b>Living arrangements before admission, No.(%)</b>			
Independent	1814 (86.7)	883 (84.9)	931 (88.5)
Nursing home	49 (2.3)	27 (2.6)	22 (2.1)
Senior residence/Assisted living	168 (8.1)	91 (8.8)	77 (7.3)
Missing	60 (2.9)	38 (3.7)	22 (2.1)
<b>Marital status, No. (%)</b>			
Married or living together	1125 (53.8)	556 (53.5)	569 (54.1)
Single or divorced	456 (21.8)	212 (20.4)	244 (23.2)
Widow/widower	435 (20.8)	224 (21.6)	211 (20.1)
Missing	75 (3.6)	47 (4.5)	28 (2.7)
<b>Charlson Comorbidity Index<sup>b</sup> (mean, SD<sup>a</sup>)</b>	2.05 (2.05)	2.10 (2.08)	2.01 (2.03)
<b>Polypharmacy, No. (%)<sup>c, d, e</sup></b>	1247 (59.6)	586 (56.4)	661 (62.8)
Missing	12 (.6)	8 (.8)	4 (.4)
<b>Hospitalization in past 6 months, No. (%)</b>	705 (33.7)	339 (32.6)	336 (34.8)
<b>Acute hospitalization, No. (%)<sup>c, f</sup></b>	73.0 (73.0)	725 (69.8)	801 (76.1)
<b>Admission ward, internal medicine No. (%)</b>	1051 (50.3)	524 (50.4)	527 (50.1)
<b>Discharge destination, No. (%)</b>			
Home	1551 (74.2)	770 (74.1)	781 (74.2)
Other health care setting, of which	482 (23.1)	238 (23.0)	244 (23.2)
Rehabilitation center	268 (12.8)	120 (11.5)	148 (14.1)
Nursing home	158 (7.6)	80 (7.7)	78 (7.4)
Assisted living	34 (1.6)	26 (2.5)	8 (0.8)
Other hospital	22 (1.1)	12 (1.2)	10 (1.0)
Missing	58 (2.8)	31 (3.0)	27 (2.6)

<sup>a</sup> Standard Deviation, <sup>b</sup> Range of 0 to 31, with a higher score indicating more or more severe comorbidity<sup>33</sup>, <sup>c</sup> Use of 5 or more different medications, <sup>d</sup> Chi-Square, <sup>e</sup> P-value = 0.004, <sup>f</sup> P-value = 0.001

**Table 2.** Interrupted time series analysis; medical and nursing handovers

	<i>Medical handovers &lt;24 hrs after discharge (%)<sup>a</sup></i>			<i>Time between discharge and medical letter (days)<sup>b</sup></i>			<i>Nursing handovers &lt;24 hrs after discharge (%)<sup>c</sup></i>		
	$\beta$ (SE)	95% CI	p-value	$\beta$ (SE)	95% CI	p-value	$\beta$ (SE)	95% CI	p-value
Intercept	17.51 (3.79)	10.08 to 24.93	<0.01	7.20 (0.29)	6.63 to 7.76	<0.01	91.85 (2.71)	86.53 to 97.16	<0.01
Trend pre-intervention ( $\beta_1$ )	1.49 (0.97)	-0.42 to 3.40	0.16	-0.30 (0.07)	-0.45 to -0.16	<0.01	0.28 (0.70)	-1.09 to 1.64	0.70
Level change directly after intervention ( $\beta_2$ )	6.43 (10.13)	-13.43 to 26.28	0.54	-0.62 (0.74)	-2.07 to 0.84	0.43	6.32 (7.25)	-7.89 to 20.53	0.41
Trend differences ( $\beta_3$ )	-0.94 (1.38)	-3.64 to 1.75	0.51	0.05 (0.10)	-0.14 to 0.25	0.61	-0.81 (0.99)	-2.74 to 1.12	0.43
	Absolute effect directly after intervention: -0.17%			Absolute effect directly after intervention: -0.25 days			Absolute effect directly after intervention: 0.62%		

$\beta_1$  estimates the pre-intervention trend.

$\beta_2$  estimates the difference between the observed level just after the intervention started and that predicted by the pre-intervention trend.

$\beta_3$  estimates the difference in trend between the pre-intervention and post-intervention period.

SE: Standard Error, CI: Confidence Interval

<sup>a</sup> Correction for autocorrelation did not provide a better model compared to the presented model (AIC 74.17 versus 72.88,  $p=0.40$ ), nor did correction for potential confounders ('polypharmacy' and 'acute admission') (AIC 74.98 versus 72.88,  $p=0.39$ ). All models led to results with similar estimates and identical interpretation.

<sup>b</sup> The results are adjusted for autocorrelation, but not for potential confounders. Correction for autocorrelation (AR1) provided a better model compared to the presented model (AIC 21.52 versus 25.72,  $p=0.01$ ). Correction for potential confounders ('polypharmacy' and 'acute admission') did not provide a better model compared to the presented model (AIC 29.23 versus 25.72,  $p=0.78$ ). Correction for autocorrelation (AR1) changed  $\beta_1$  into a significant result. Correction for potential confounders did not alter the results.

<sup>c</sup> Correction for autocorrelation did not provide a better model compared to the presented model (AIC 66.05 versus 59.13,  $p=0.02$ ), nor did correction for potential confounders ('polypharmacy' and 'acute admission') (AIC 59.03 versus 59.13,  $p=0.13$ ). All models led to results with similar estimates and identical interpretation.

**Figure 1. Pyramid for postdischarge care**

A structured discharge process such as the TIP procedure should form the basis for every patient. For patients discharged with postdischarge care (20-25%), nursing handovers should be set up within 48h after admission and be sent within 24h postdischarge. Complex patients with a high readmission risk (10%) require a (nurse) case manager or transitional care in the transition from hospital to home.

**Figure 2.**

**Panel A** The number of medical handovers sent within 24 hours.

**Panel B** median time in days between discharge and the medical handovers.

**Figure 3. Hospital differences based on implementation score.**

The inter-hospital differences in rates of medical handovers being sent within 24h in the pre- and post-intervention based on the extent of implementation and used implementation strategies. Group 1 received >30 feedback implementation points, group 2 received 20-30 implementation points, group 3 received <20 points.

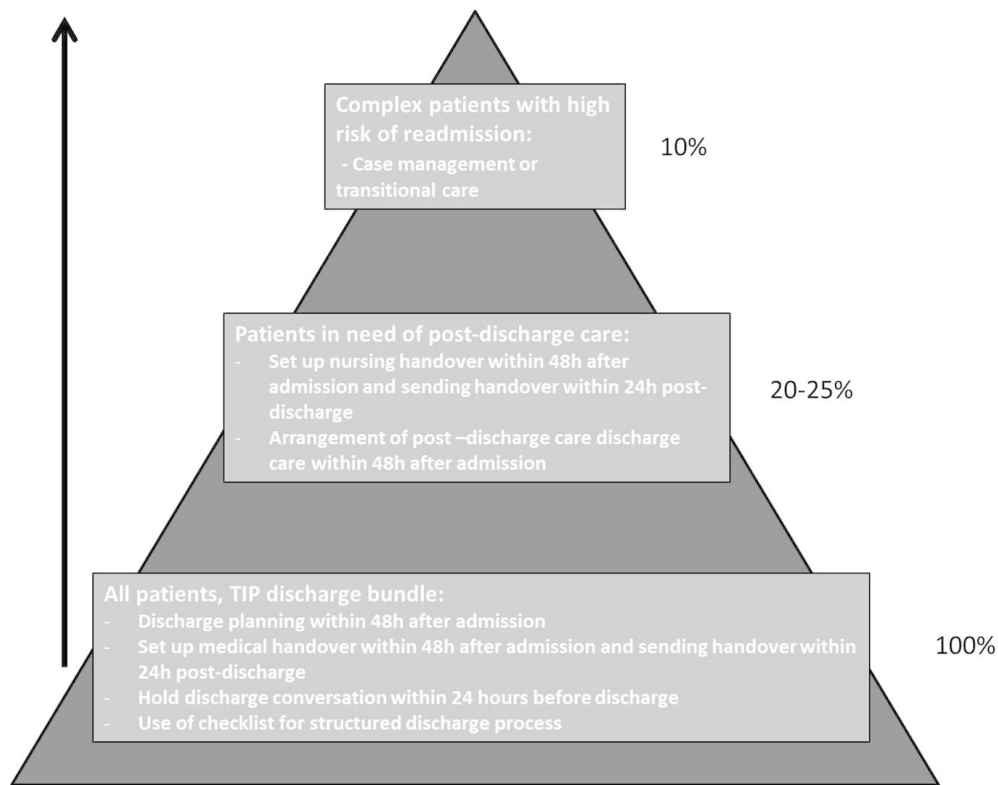


Figure 1. Pyramid for post-discharge care A structured discharge process such as the TIP procedure should form the basis for every patient. For patients discharged with post-discharge care (20-25%), nursing handovers should be set up within 48h after admission and be sent within 24h post-discharge. Complex patients with a high readmission risk (10%) require a (nurse) case manager or transitional care in the transition from hospital to home.

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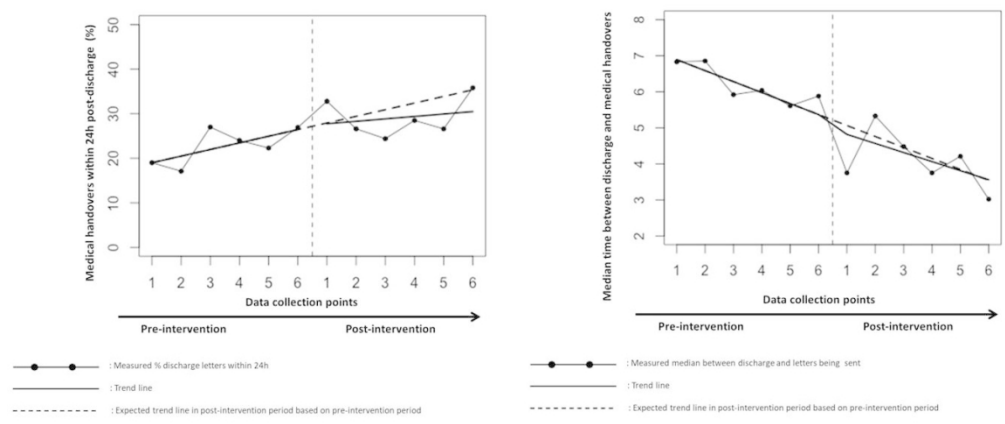


Figure 2.  
 Panel A The number of medical handovers sent within 24 hours.  
 Panel B median time in days between discharge and the medical handovers.

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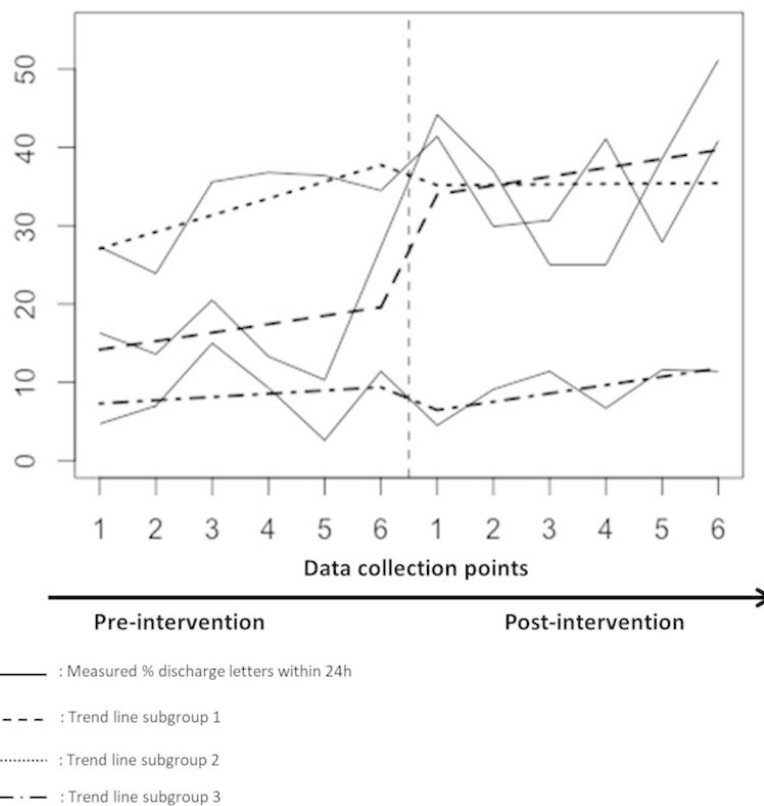


Figure 3. Hospital differences based on implementation score. The inter-hospital differences in rates of medical discharge letters being sent within 24h in the pre- and post-intervention based on the extent of implementation and used implementation strategies. Group 1 received >30 feedback implementation points, group 2 received 20-30 implementation points, group 3 received <20 points.

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**Supplement Table 1.** Adherence to the Intervention Protocol

	Hospital 1	Hospital 2	Hospital 3	Hospital 4	Hospital 5	Hospital 6	Hospital 7	Hospital 8
Pre-intervention	Sep '15 - Feb '16	Oct '15 - March '16	Jan '16 - June '16	Dec '15 - May '16	March '16 – Aug '16	April '16 – Sep '16	May '16 – Oct '16	April '16 – Sep '16
Implementation	March '16 - April '16	April '16 - May '16	July '16 - Aug '16	June '16 - July '16	Sep '16 - Oct '16	Oct '16 - Nov '16	Nov '16 - Dec '16	Oct '16 - Nov '16
Post-intervention	May '16 – Oct '16	June '16 - Nov '16	Sep '16 – Feb '17	Aug '16 - Jan '16	Nov '16 – April '17	Dec '16 – May '17	Jan '17 – June '17	Dec '16 – May '17
<b>Leadership and education of project leaders</b>								
Who were present at the kick off meeting February, 2016?	Hospital president; local project leader; 2 team leaders (nurses); 2 physicians; nurse; pharmacists	Local project leader; geriatrician; head of the liaison department; physician	2 local project leaders; head of the liaison department	Chief of staff; local project leader; team leader surgery ward (nurse); head of the liaison department	Local project leader; head of the liaison department; manager patient logistics; 2 team leaders (nurses)	2 local project leaders	Local project leader	Local project leader; senior researcher transitional care; medical specialist,
Who were present at the first feedback session?	Project leader; head of the liaison department	Project leader; pharmacist; communication assistant	2 local project leaders; liaison nurse	Project leader; liaison nurse; nurse geriatrics	Local project leader	2 local project leaders	-	2 project leaders
Who were present at the second feedback session?	Project leader	Project leader	2 project leaders	-	Project leader	-	Project leader	2 project leaders
<i>Implementation points</i>	10	8	8	7	7	4	2	7
<b>Project group</b>								
Was there a local TIP project group, and who participated?	Yes, project leader; 2 senior nurses of participating wards, management assistant	Yes, project leader; geriatrician; head liaison department, physician; pharmacist; communication assistant; manager Security & Services	Yes, 2 project leaders; 2 residents; 2 medical specialists; nurse; liaison nurse; pharmacist; manager	Yes, chief of staff; project leader; 2 team leaders (nurses); head liaison department; orthopedist	Yes, project leader; head liaison department; 2 medical specialists, geriatrician	No	No	Yes, local project leader; 3 medical specialists; 2 residents, manager quality and safety; manager process optimization; medical director
How often did the local project group meet? 1 point per meeting	Monthly for 2 months, during pilot period every week (2 months).	Every five weeks during pre-intervention and pilot period	2 times, before pilot period.	Every two weeks during pre-intervention period	Every six weeks, during pre-intervention and pilot period	-	-	Monthly during pre-intervention, pilot period and first two months of post-

								intervention period
<i>Implementation points</i>	10	12	10	18	10	0	0	17
<b>Implementation of TIP elements</b>								
Was it policy to set a discharge date within 48h after admission?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Was the planned discharge date communicated to patients?	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Was it policy to start with arrangement of required post-discharge care within 48h after admission?	No, liaison nurse has to wait for final discharge date	No, liaison nurse has to wait for final discharge date	Yes	Yes	No, liaison department is overloaded	Yes	No, liaison nurse has to wait for final discharge date	Yes
Was it policy to set up patient handovers within 48h after admission?	No	No	No	No	No	No	No	No
Did physicians hold discharge conversations, using a checklist during the pilot period?	No	No	No	No	No	No	No	No
Does the nurse holds a discharge conversation, using a checklist?	Yes	No	Yes	Yes	Yes	No	Yes	Yes
Was the patient discharge letter implemented?	Yes, but only for some diagnosis at internal medicine ward.	No	No	No	No	Yes, but only at internal medicine ward for frail older patients.	No	No, a discharge summary was implemented instead.
<i>Implementation points</i>	3.5	2	4	4	3	2.5	3	4.5
<b>Education of physicians and nurses</b>								

1	How were physicians and nurses informed about the TIP and how often?	Kick-off meeting at participating wards; during morning report; working instructions were sent by email to all physicians	Kick-off meeting; meeting at participating wards; E-learning; 1 feedback meeting	During morning reports; project leader informed every physician separately; intranet; email	During morning reports; intranet; email; posters & pocket cards; and project leaders went to participating wards to inform physicians and nurses	Email and project leader went to participating wards	Kick-off meeting, during several morning reports	Physicians were not educated with regard to the intervention	During several morning report; email; project leaders went to participating wards to inform physicians and nurses; medical specialists from project group informed physicians in person									
2	Did physicians and/or nurses receive feedback with regard to their discharge letters and if yes, how often?	No	No	No	No	No	Only for nurses	No	Yes, daily on internal medicine and monthly on surgery ward, via email.									
3	<i>Implementation points</i>	3	4	4	5	2	2.5	0	5									
4	<b>Total implementation points</b>	<b>26.5</b>	<b>26</b>	<b>26</b>	<b>34</b>	<b>22</b>	<b>9</b>	<b>5</b>	<b>33.5</b>									
5	<b>Pre-intervention vs. post-intervention period scores</b>																	
6	<b>Pre-intervention period</b>																	
7	median	% letters within 24h	8.15	9.0	0.90	47.3	6.71	23.5	10.48	13.1	0.79	50.0	6.79	9.2	14.21	7.6	5.83	20.9
8	<b>Post-intervention</b>																	
9	median	% letters within 24h	9.08	19.5	1.0	48.5	5.48	24.2	5.79	19.7	0.29	49.6	7.98	16.7	22.44	1.5	0.83	53.8

**Revised Standards for Quality Improvement Reporting Excellence (SQUIRE 2.0)  
September 15, 2015**

Text Section and Item Name	Section or Item Description
<b>Notes to authors</b>	<ul style="list-style-type: none"> <li>• The SQUIRE guidelines provide a framework for reporting new knowledge about how to improve healthcare</li> <li>• The SQUIRE guidelines are intended for reports that describe <a href="#">system</a> level work to improve the quality, safety, and value of healthcare, and used methods to establish that observed outcomes were due to the <a href="#">intervention(s)</a>.</li> <li>• A range of approaches exists for improving healthcare. SQUIRE may be adapted for reporting any of these.</li> <li>• Authors should consider every SQUIRE item, but it may be inappropriate or unnecessary to include every SQUIRE element in a particular manuscript.</li> <li>• The SQUIRE Glossary contains definitions of many of the key words in SQUIRE.</li> <li>• The Explanation and Elaboration document provides specific examples of well-written SQUIRE items, and an in-depth explanation of each item.</li> <li>• Please cite SQUIRE when it is used to write a manuscript.</li> </ul>
<b>Title and Abstract</b>	
<b>1. Title</b>	Indicate that the manuscript concerns an <a href="#">initiative</a> to improve healthcare (broadly defined to include the quality, safety, effectiveness, patient-centeredness, timeliness, cost, efficiency, and equity of healthcare)
<b>2. Abstract</b>	<ol style="list-style-type: none"> <li>a. Provide adequate information to aid in searching and indexing</li> <li>b. Summarize all key information from various sections of the text using the abstract format of the intended publication or a structured summary such as: background, local <a href="#">problem</a>, methods, interventions, results, conclusions</li> </ol>
<b>Introduction</b>	<i>Why did you start?</i>
<b>3. <a href="#">Problem Description</a></b>	Nature and significance of the local <a href="#">problem</a>
<b>4. Available knowledge</b>	Summary of what is currently known about the <a href="#">problem</a> , including relevant previous studies

5. <b><u>Rationale</u></b>	Informal or formal frameworks, models, concepts, and/or <a href="#">theories</a> used to explain the <a href="#">problem</a> , any reasons or <a href="#">assumptions</a> that were used to develop the <a href="#">intervention(s)</a> , and reasons why the <a href="#">intervention(s)</a> was expected to work
6. <b>Specific aims</b>	Purpose of the project and of this report
<b>Methods</b>	<i>What did you do?</i>
7. <b><u>Context</u></b>	Contextual elements considered important at the outset of introducing the <a href="#">intervention(s)</a>
8. <b><u>Intervention(s)</u></b>	<ul style="list-style-type: none"> <li>a. Description of the <a href="#">intervention(s)</a> in sufficient detail that others could reproduce it</li> <li>b. Specifics of the team involved in the work</li> </ul>
9. <b>Study of the Intervention(s)</b>	<ul style="list-style-type: none"> <li>a. Approach chosen for assessing the impact of the <a href="#">intervention(s)</a></li> <li>b. Approach used to establish whether the observed outcomes were due to the <a href="#">intervention(s)</a></li> </ul>
10. <b>Measures</b>	<ul style="list-style-type: none"> <li>a. Measures chosen for studying <a href="#">processes</a> and outcomes of the <a href="#">intervention(s)</a>, including rationale for choosing them, their operational definitions, and their validity and reliability</li> <li>b. Description of the approach to the ongoing assessment of contextual elements that contributed to the success, failure, efficiency, and cost</li> <li>c. Methods employed for assessing completeness and accuracy of data</li> </ul>
11. <b>Analysis</b>	<ul style="list-style-type: none"> <li>a. Qualitative and quantitative methods used to draw <a href="#">inferences</a> from the data</li> <li>b. Methods for understanding variation within the data, including the effects of time as a variable</li> </ul>
12. <b>Ethical Considerations</b>	<a href="#">Ethical aspects</a> of implementing and studying the <a href="#">intervention(s)</a> and how they were addressed, including, but not limited to, formal ethics review and potential conflict(s) of interest
<b>Results</b>	<i>What did you find?</i>
13. <b>Results</b>	<ul style="list-style-type: none"> <li>a. Initial steps of the <a href="#">intervention(s)</a> and their evolution over time (e.g., time-line diagram, flow chart, or table), including modifications made to the intervention during the project</li> <li>b. Details of the <a href="#">process</a> measures and outcome</li> <li>c. Contextual elements that interacted with the <a href="#">intervention(s)</a></li> <li>d. Observed associations between outcomes, interventions, and relevant contextual elements</li> <li>e. Unintended consequences such as unexpected benefits, problems, failures, or costs associated with the <a href="#">intervention(s)</a>.</li> <li>f. Details about missing data</li> </ul>
<b>Discussion</b>	<i>What does it mean?</i>
14. <b>Summary</b>	<ul style="list-style-type: none"> <li>a. Key findings, including relevance to the <a href="#">rationale</a> and specific aims</li> <li>b. Particular strengths of the project</li> </ul>

<p>1 2 3 4 5 6 7 8 9 10 11</p> <p><b>15. Interpretation</b></p>	<p>a. Nature of the association between the <a href="#">intervention(s)</a> and the outcomes</p> <p>b. Comparison of results with findings from other publications</p> <p>c. Impact of the project on people and <a href="#">systems</a></p> <p>d. Reasons for any differences between observed and anticipated outcomes, including the influence of <a href="#">context</a></p> <p>e. Costs and strategic trade-offs, including <a href="#">opportunity costs</a></p>
<p>12 13 14 15 16</p> <p><b>16. Limitations</b></p>	<p>a. Limits to the <a href="#">generalizability</a> of the work</p> <p>b. Factors that might have limited <a href="#">internal validity</a> such as confounding, bias, or imprecision in the design, methods, measurement, or analysis</p> <p>c. Efforts made to minimize and adjust for limitations</p>
<p>17 18 19 20 21 22</p> <p><b>17. Conclusions</b></p>	<p>a. Usefulness of the work</p> <p>b. Sustainability</p> <p>c. Potential for spread to other <a href="#">contexts</a></p> <p>d. Implications for practice and for further study in the field</p> <p>e. Suggested next steps</p>
<p>23 24</p> <p><b>Other information</b></p>	
<p>25 26 27</p> <p><b>18. Funding</b></p>	<p>Sources of funding that supported this work. Role, if any, of the funding organization in the design, implementation, interpretation, and reporting</p>



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3 **Table 2. Glossary of key terms used in SQUIRE 2.0. This Glossary provides the intended**  
4 **meaning of selected words and phrases as they are used in the SQUIRE 2.0 Guidelines. They**  
5 **may, and often do, have different meanings in other disciplines, situations, and settings.**  
6

### 7 **Assumptions**

8 Reasons for choosing the activities and tools used to bring about changes in healthcare services at  
9 the [system](#) level.  
10  
11

### 12 **Context**

13 Physical and sociocultural makeup of the local environment (for example, external environmental  
14 factors, organizational dynamics, collaboration, resources, leadership, and the like), and the  
15 interpretation of these factors (“sense-making”) by the healthcare delivery professionals, patients,  
16 and caregivers that can affect the effectiveness and [generalizability](#) of [intervention\(s\)](#).  
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### 19 **Ethical aspects**

20 The value of [system](#)-level [initiatives](#) relative to their potential for harm, burden, and cost to the  
21 stakeholders. Potential harms particularly associated with efforts to improve the quality, safety, and  
22 value of healthcare services include [opportunity costs](#), invasion of privacy, and staff distress  
23 resulting from disclosure of poor performance.  
24  
25

### 26 **Generalizability**

27 The likelihood that the [intervention\(s\)](#) in a particular report would produce similar results in other  
28 settings, situations, or environments (also referred to as external validity).  
29  
30

### 31 **Healthcare improvement**

32 Any systematic effort intended to raise the quality, safety, and value of healthcare services, usually  
33 done at the [system](#) level. We encourage the use of this phrase rather than “quality improvement,”  
34 which often refers to more narrowly defined approaches.  
35  
36

### 37 **Inferences**

38 The meaning of findings or data, as interpreted by the stakeholders in healthcare services –  
39 improvers, healthcare delivery professionals, and/or patients and families  
40  
41

### 42 **Initiative**

43 A broad term that can refer to organization-wide programs, narrowly focused projects, or the details  
44 of specific interventions (for example, planning, execution, and assessment)  
45  
46

### 47 **Internal validity**

48 Demonstrable, credible evidence for efficacy (meaningful impact or change) resulting from  
49 introduction of a specific intervention into a particular healthcare [system](#).  
50  
51

### 52 **Intervention(s)**

53 The specific activities and tools introduced into a healthcare [system](#) with the aim of changing its  
54 performance for the better. Complete description of an intervention includes its inputs, internal  
55 activities, and outputs (in the form of a logic model, for example), and the mechanism(s) by which  
56 these components are expected to produce changes in a [system's](#) performance.  
57  
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### 59 **Opportunity costs**

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2  
3 Loss of the ability to perform other tasks or meet other responsibilities resulting from the diversion  
4 of resources needed to introduce, test, or sustain a particular [improvement](#) initiative  
5  
6

### 7 **Problem**

8 Meaningful disruption, failure, inadequacy, distress, confusion or other dysfunction in a healthcare  
9 service delivery [system](#) that adversely affects patients, staff, or the [system](#) as a whole, or that  
10 prevents care from reaching its full potential  
11

### 12 **Process**

13 The routines and other activities through which healthcare services are delivered  
14  
15

### 16 **Rationale**

17 Explanation of why particular [intervention\(s\)](#) were chosen and why it was expected to work, be  
18 sustainable, and be replicable elsewhere.  
19

### 20 **Systems**

21 The interrelated structures, people, [processes](#), and activities that together create healthcare services  
22 for and with individual patients and populations. For example, systems exist from the personal self-  
23 care system of a patient, to the individual provider-patient dyad system, to the microsystem, to the  
24 macrosystem, and all the way to the market/social/insurance system. These levels are nested within  
25 each other.  
26  
27

### 28 **Theory or theories**

29 Any “reason-giving” account that asserts causal relationships between variables (causal theory) or  
30 that makes sense of an otherwise obscure [process](#) or situation (explanatory theory). Theories come  
31 in many forms, and serve different purposes in the phases of [improvement](#) work. It is important to  
32 be explicit and well-founded about any informal and formal theory (or theories) that are used.  
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