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Associations between early handoffs, length of stay and complications in internal medicine wards: A retrospective study

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ABSTRACT

Background: In US healthcare system, handoffs are associated with an increase in medical error and in hospital length of stay. In non-US healthcare systems, this phenomenon has not been well studied. We studied the association between early handoffs (EH) in a non-US internal medicine ward with length of stay (LOS), use of resources, major complication (MC) and discharge to post-acute care (PAC) facility.

Methods: We conducted a retrospective cohort study on patients admitted to the general internal medicine division. Patients with EH (defined as a transfer of responsibility between primary teams within the first 72 h) were compared with patients without EH. The primary outcome was LOS in the general internal medicine division. Secondary outcomes were the use of resources, the incidence of MC (transfer to intensive care, to intermediate care or death) and discharge to a PAC facility.

Results: We included 11,869 patients, 38% of whom were in the EH group. Patients were 67.7 ± 16.6 years old and 53% were males. EH was independently associated with an increase of LOS (+6.4% [95% CI, 3.5%–9.5%], P < .001) and with an increased rate of MC (OR 1.3 [95% CI, 1.1–1.7], P = .012). In our subgroup analysis, the association between early handoff and LOS and MC rate were not statistically significant when the admission occurred on public holidays and weekends.

Conclusions: Among patients admitted in our general internal medicine division, early handoffs were associated with significantly higher length of stay and major complication rate, but not in patients admitted during weekends.

1. Introduction

Continuity of care is a key feature for high quality of care. To maintain the continuity of care of patients in the hospital, physicians conduct clinical handoffs (also called sign-outs or handovers) to transfer both patient information and accountability from one provider or team to another [1]. Handoffs occur between day and night teams (inter-shift), during rotations of primary day teams, or ward transfers (intra-hospital). The format and content of the handoffs vary widely, according to the type of handoff and local practices.

Handoffs are associated with an increased risk of complications [2,3] and an increased length of stay [4,5]. Recent legal regulations on working hours have increased the number of shifts and, consequently, the number of handoffs, by up to 40% [6]. In a U.S. study, almost 60% of physicians report that one or more patients had been harmed during their most recent clinical rotation because of problematic handoffs, and 12% reported that this harm had been major [7]. Handoff-related problems occur with a frequency of 7.5 per 100 patient-days of care, and can contribute to adverse clinical consequences for patients, as well as inefficient or duplicative work by health care providers [8]. Moreover, improving handoffs can result in a decrease of the rate of medical error [9,10] and in cost reduction [11].

Different types of handoffs (i.e., intra-shift, intra-hospital handoffs) all increase the risk of adverse events [12]. In a U.K. study of self-reported critical incidents, the transfer of patient care within the same specialty (intra-specialty handoff) accounted for 51% of all handoff incidents; although most of these incidents occurred during inter-shift handoffs, about a quarter of the incidents was due transfers between

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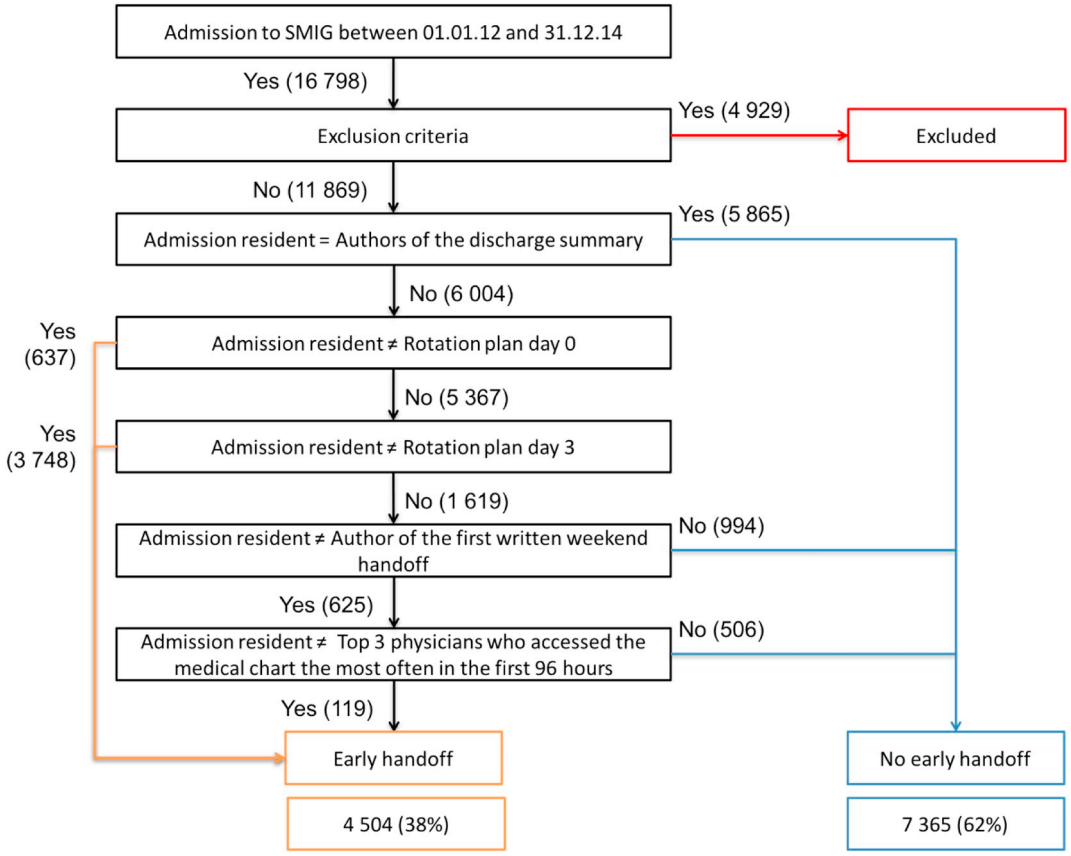

Fig. 1. Flowchart of patients' inclusion and handoff algorithm. We first compared the admission resident to the discharge resident, and, if it was identical, the patient was attributed to the control (no-handoff) group. For the remaining patients, we then compared the admission resident to the resident in charge based on rotation plan, which indicates which resident was in each ward during the study period, the resident who signed the first written weekend handoff, and the 3 residents who accessed the electronic medical record the most often in the first 96 h in internal medicine wards. A 96 h-limit was set to avoid selecting patients who required more night-time or weekend management (access log). We considered patients who had different residents for all these tasks as early handoff patients. The others were attributed to the control group.

specialty wards [13]. An early U.S. study on handoffs showed that early transfer of responsibility from a resident to another the day after admission was associated with longer inpatient stays and higher use of laboratory tests [4]. Handoffs have not been well studied in European hospital settings, particularly in Internal Medicine [10], and the structure and organization of General Internal Medicine wards can vary largely between hospitals, particularly if we compare European and U.S. institutions.

The objective of this study was to analyze early handoffs, which were defined as handoffs occurring between daytime internal medicine residents within the first 72 h of a patient's admission to a general internal medicine ward. We aimed to study the association between early handoffs and measures of quality and cost of care (length of stay (LOS), use of resources, incidence of major complications and discharge to post-acute care facility). The hypothesis was that transferring responsibility of care early after the admission would increase the length of stay, with an additional use of resources, but without increasing the incidence of complications.

2. Patients and methods

2.1. Study setting

This retrospective cohort study was conducted in the Division of General Internal Medicine of Geneva University Hospitals, a teaching hospital with a residency program in internal medicine. There are close to 8000 admissions per year and up to 193 beds in Internal Medicine. The vast majority of admissions to this division are for acute clinical care, including admissions directly from the emergency department (~80%) and transfers from other departments.

Residents work in General Internal Medicine wards during 4- to 6-week rotations, with regular day shifts (8:00 AM–6:00 PM) from Monday to Friday. All other periods (evenings, nights, weekends and bank holidays) are covered by an “on-call team”. During business hours, each day-team resident oversees patients in pre-defined rooms (half of the ward) under the supervision of an attending: this allocation of patients by rooms helps avoid practices of patient trading (e.g., difficult caring). They document the admission and progress notes, and write the discharge summary (no early handoff). However, residents other than the primary care team may admit patients in certain situations, with a resulting early handoff: These situations are: (1) during week-ends, as patients are admitted by the on-call team, with subsequent follow-up by the day-team resident during the week, (2) patients with private insurance who are admitted in a two-step process, as they may be transferred from a general ward to a private sector room if a bed becomes available within 48 h of the admission, (3) in case of work overload or unexpected absences (e.g. sick leave), where other residents will pitch in and help admit a patient and (4) finally, patients admitted at the end of the rotation, who are handed off to the next rotation day-team.

2.2. Participants

We enrolled all adults (> 18 years old) who were hospitalized in general internal medicine wards between Jan 1, 2012 and Dec 31, 2014, defined by a stay of > 24 h. Exclusion criteria were patients with

Table 1
Patients characteristics[a].

	All patients (n = 11,869)	Control group (n = 7365)	Early handoff group (n = 4504)	P-value
Female sex – no (%)	5601 (47.2)	3477 (47.2)	2124 (47.2)	0.956
Age – yr	67.7 ± 16.6	67.0 ± 16.5	68.7 ± 16.8	< 0.001
Age – no (%)				< 0.001
< 55	2415 (20.4)	1564 (21.2)	851 (18.9)	
55–64	1868 (15.7)	1219 (16.6)	649 (14.4)	
65–74	2787 (23.5)	1785 (24.2)	1002 (22.3)	
75–84	3096 (26.1)	1835 (24.9)	1261 (28.0)	
85+	1703 (14.4)	962 (13.1)	741 (16.5)	
Marital status – no (%)				< 0.001
Single	1909 (16.1)	1220 (16.6)	689 (15.3)	
Couple	5438 (45.8)	3440 (46.7)	1998 (44.4)	
Divorced	2258 (19.0)	1416 (19.2)	842 (18.7)	
Widower	2250 (19.0)	1281 (17.4)	969 (21.5)	
Unknown	14 (0.1)	8 (0.1)	6 (0.1)	
First language – no (%)				0.126
French	7980 (67.2)	4917 (66.8)	3063 (68.0)	
Italian	1128 (9.5)	729 (9.9)	399 (8.9)	
Spanish	630 (5.3)	402 (5.5)	228 (5.1)	
Portuguese	484 (4.1)	311 (4.2)	173 (3.8)	
German	344 (2.9)	198 (2.7)	146 (3.2)	
Other	1303 (11.0)	808 (11.0)	495 (11.0)	
Private sector – no (%)	2078 (17.5)	1239 (16.8)	839 (18.6)	0.012
Previous hospitalization – no (%)	7108 (59.9)	4430 (60.2)	2678 (59.5)	0.456
Comorbidities – no (%)				0.304
0	597 (5.0)	360 (4.9)	237 (5.3)	
1–2	3690 (31.1)	2315 (31.4)	1375 (30.5)	
3–4	3995 (33.7)	2501 (34.0)	1494 (33.2)	
5+	3587 (30.2)	2189 (29.7)	1398 (31.0)	
Provenance – no (%)				< 0.001
Home	1323 (11.2)	1069 (14.5)	254 (5.6)	
Other hospital	87 (0.7)	64 (0.9)	23 (0.5)	
ED	8713 (73.4)	5116 (69.5)	3597 (79.9)	
Intensive care unit	775 (6.5)	443 (6.0)	332 (7.4)	
Intermediate care unit	235 (2.0)	115 (1.6)	120 (2.7)	
Other speciality	255 (2.2)	170 (2.3)	85 (1.9)	
Divers	481 (4.1)	388 (5.3)	93 (2.1)	
Initial vital sign				
sBP – mmHg	124.0 ± 20.4	123.9 ± 20.4	124.2 ± 20.4	0.428
dBP – mmHg	71.6 ± 13.8	71.8 ± 13.9	71.2 ± 13.7	0.014
Heart rate – per min	83.9 ± 16.7	84.0 ± 17.1	83.8 ± 16.1	0.663
SpO2 – %	96.2 ± 12.7	96.2 ± 11.8	96.2 ± 14.2	0.827
Respiratory rate – per min	19.8 ± 5.6	19.9 ± 5.8	19.7 ± 5.2	0.189
Temperature – °C	36.9 ± 0.7	36.9 ± 0.7	36.9 ± 0.7	0.495
Weight – kg	73.3 ± 20.1	73.2 ± 20.2	73.5 ± 19.8	0.654
Height – cm	166.7 ± 9.8	166.7 ± 9.7	166.5 ± 9.9	0.552
Initial lab value				
Sodium – mmol/l	136.5 ± 4.7	136.5 ± 4.7	136.5 ± 4.8	0.988
Albumin – g/l	29.7 ± 6.1	29.8 ± 6.2	29.5 ± 5.9	0.015
Creatinin – µmol/l	123.8 ± 131.5	123.6 ± 129.4	124.2 ± 134.5	0.792
MDRB status – no (%)	1988 (16.8)	1210 (16.4)	778 (17.3)	0.232
Switch of supervisor – no (%)	4497 (37.9)	1750 (23.8)	2747 (61.0)	< 0.001
Student involvement – no (%)	3090 (26.0)	2515 (34.2)	575 (12.8)	< 0.001
On-call admission – no (%)	2861 (24.1)	182 (2.5)	2679 (59.5)	< 0.001

sBP = systolic blood pressure; dBP = diastolic blood pressure; MDRB = Multi-drug resistant bacteria.
[a] Plus–minus values are means ± SD.

a LOS < 72 h in internal medicine wards, patients without an admission note (required to define early handoff) and patients with LOS over 6 weeks (corresponding to outlier patients). We also excluded patients in wards solely managed by speciality fellows and residents such as onco-haematology and prison patients.

2.3. Variables

We defined early handoff patients as those who had a transfer of responsibility between primary teams within the first 72 h in internal medicine wards. We use a sequential multifactorial algorithm to identify early handoff patients (Fig. 1). Basically, we compared the admission resident with the resident in charge of the patient at day 3, based on different variables. If the admission resident and the day-3 resident was the identical, the patient was attributed to the control (no-handoff) group. If not, it was attributed to the handoff group. Handoffs were completed either in person or in written points. Attending physicians were not involved in handoffs.

Outcomes were length of stay (LOS) in internal medicine division, use of resources (a composite outcome of laboratory tests and radiologic exams), the incidence of major complications (MC) in internal medicine division (composite outcome of transfers to the intensive care unit (ICU) or intermediate care station (ICS) and death in the internal medicine division) and discharge to a post-acute care (PAC) facility. We performed a sensitivity analysis on the primary outcome with the total hospital LOS (including stays in other wards after the qualifying internal medicine stay). The association with the destination of discharge was studied as a pre-specified exploratory hypothesis.

We extracted and de-identified demographic characteristics and medical data from the medical charts, such as vital signs and lab values at the time of admission in the internal medicine division. Non-structured data were extracted by natural language processing. Certain data required manual extraction from the electronic medical records. Comorbidities were coded using the Multipurpose Australian Comorbidity Scoring System [14].

2.4. Statistics analyses

Student *t*-test, Mann-Whitney-Wilcoxon test and Chi2 test were used for comparisons across groups. We used univariate and multivariable linear and logistic regression models to assess the association between the early transfer of responsibility and (1) LOS, (2) use of resources, (3) incidence of MC and (4) discharge to PAC facility.

For the multivariable analysis, models included gender, age, comorbidities, marital status, insurance status, MDRB status, previous hospitalizations, discharge to a PAC facility, LOS in internal medicine division, switch of supervisor and student involvement (based on admission note). We assessed for effect modification by admission vitals and lab results, and admission day (weekday or day off). Sensitivity analyses on total LOS and morbidity were post-hoc analyses.

For all tests, a two-sided P value of < 0.05 was considered significant. Statistical analyses were performed using STATA version 15 (Stata Corporation, Texas, US).

2.5. Power

Based on an average 8 days stay on the internal medicine wards, with an early handoff estimated in one in four cases, a sample size of 10,720 patients (2680 and 8040) was estimated to provide 80% power to detect a difference of 0.5 day in LOS.

2.6. Ethics

This study was approved by the local ethics committee (CCER no. 14-255).

3. Results

Among 16,798 patients admitted during the study period, 4929 did not meet the inclusion criteria (2871 with LOS $<$ 72 h, 1979 had no admission note and 79 with LOS $>$ 42 days). We included 11,869 patients, with 4504 (38%) in the early handoff group and 7365 (62%) in the control group (Fig. 1).

Patient characteristics are shown in Table 1. Patients were 67.7 ± 16.6 years old and 53% were males. No statistical difference was found between early handoff and control groups in terms of gender, comorbidities, first language, MDRB status, main initial vital signs or lab values. Although a statistical difference was found for age, marital status, private sector, diastolic blood pressure (dBP) and albumin, these differences had no clinical significance. Early handoff patients were less likely to be admitted electively but were more likely to be admitted during on-call days, and to have a change of supervisor. Students were less likely to be involved in early handoff patients (less students during weekend shifts).

For the primary outcome, the overall LOS in our service was 10.1 days with a significant difference between early handoff and control groups (10.3 ± 6.4 days vs 10.0 ± 6.2 days, P = .023) (Table 2). After adjustment, early handoff was associated with an increase of 6.4% (0.7 day) in LOS (95%CI, 3.5–9.5, P $<$ .001) (Table 3). In the adjusted analysis, other factors associated with an increase in LOS were a change of supervisor (+18.0% [95%CI, 14.8%–21.3%], p $<$ .001), more than five comorbidities (+46.5% [95%CI, 40.1%–53.3%], P $<$ .001), admission to the private sector (+15.3% [95%CI, 12.4%–18.2%], P $<$ .001), and discharge to a PAC facility (+35.5% [95%CI, 32.4%–38.7%], P $<$ .001). In the subgroup analysis, the association between early handoff or switch of supervisor and LOS was not significant for patients admitted during on-call days (respectively −1.10% [95%CI, −13.1–12.8], P = .880 and − 1.5% [95%CI, −15.7%–15.1%], P = .847). Finally, our post-hoc sensitivity analysis on the total hospital LOS showed similar results, with a significant difference between early handoff and control group (12.7 days [95%CI, 12.4–13.0] vs 12.2 days [95%CI, 12.0–12.5], P = .0168).

For the secondary outcomes, the overall rate of MC was 6.2%, and was different between early handoff and control groups (7.1% [95%CI, 6.4%–7.9%] vs 5.6% [95%CI, 5.1%–6.2%], P = .001). Multivariable logistic regression showed that early handoff was significantly associated with MC (OR = 1.3 [95%CI, 1.1–1.7], P = .012) (Table 4). This association, however, was not present in patients admitted during on-call days (OR = 0.7 [95%CI, 0.3–1.9], P = .520). Other factors associated with MC were a change of supervisor (OR = 1.5 [95%CI, 1.2–1.8], P = .001), higher number of comorbidities (for $>$ 5, OR = 5.6 [95%CI, 3.3–9.7], P $<$ .001), admission to a private sector (OR = 1.5 [95%CI, 1.2–1.8], P $<$ .001), and MDRB status (OR = 1.7 [95%CI, 1.4–2.0], P $<$ .001). Our post-hoc sensitivity analysis on total hospital mortality showed no difference between early handoff and control groups (3.9% [95%CI, 3.4%–4.5%] vs 3.4% [95%CI, 3.0%–3.9%], P = .202). Overall, 18.9 labs or radiology tests were used, with no difference between the two groups (18.8 ± 15.4 exams vs 19.1 ± 15.7 exams, P = .233) (Table 2). The multivariable analyses did not show an association between early handoff or change of supervisor, and use of resources (Table 4). The overall rate of discharge to a post-acute care facility was 25.2%, and was higher in the early handoff group (26.3% [95%CI, 24.9%–27.7%] vs 24.5% [95%CI, 23.5%–25.6%], P = .047). Multivariable logistic regression did not show a significant association between early handoff and discharge to a PAC facility (OR = 0.9 [95%CI, 0.8–1.0], P = .076) (Table 4).

4. Discussion

In this study of general internal medicine patients, handoffs during the 72 first hours of hospitalization was associated with a longer LOS and a higher rate of MC. There was no association, however, with the use of resources or with discharge to a PAC facility.

In our study, 4 out of ten patients had early handoffs, which was higher than our estimate from previous studies (11% to 35%) [2,15]. This higher rate could be explained by the Swiss labor law of 50-hour/week for physicians, thus involving more physician shifts in patient care with more subsequent handoffs. It could also be explained by the fact that 25% of patients were hospitalized during weekends or public holidays and that the large majority of these patients (94%) had an early handoff, as they were admitted by the on-call team rather than the day teams. Finally, our institution is a large teaching hospital, offering several subspecialty rotations to residents. It seems very likely that the handoff rate would be lower in a non-teaching hospital.

Early handoffs were associated with an increased LOS. We hypothesized that physicians who did not admit the patient would need additional time to reassess the different issues for adequate management. This can drive delays in medical decisions on the patient's care and his discharge, leading to an increase in the LOS. The difference in primary endpoint may seem small in absolute value. It represents, however, an annual decrease of 500 to 1000 patient care days. These cumulated benefits gain relevance with our Diagnosis-related group payment system.

The mean LOS in our sample was longer than the average stay in internal medicine (10.1 days versus 8 days), and was probably due to the exclusion of patients with a LOS $<$ 72 h.

During handoffs, important knowledge about the patient may be omitted (e.g., allergy, comorbidity), with potential consequences on the rest of the patient's care. Our major complication outcome was a composite of transfers to the ICU/ICS and of death. The MC rate was

Table 2
Primary and secondary outcomes[a].

	All patients (n = 11,869)	Control group (n = 7365)	Early handoff group (n = 4504)	P-value
Length of stay – d	10.1 ± 6.3	10.0 ± 6.2	10.3 ± 6.4	0.023
Number of resources used – n	18.9 ± 15.5	18.8 ± 15.4	19.1 ± 15.7	0.233
1) Blood analysis	17.0 ± 13.9	16.8 ± 13.8	17.3 ± 14.1	0.098
2) Radiologic exams	1.9 ± 2.7	2.0 ± 2.7	1.9 ± 2.6	0.088
Major complications – no (%)	736 (6.2)	415 (5.6)	321 (7.1)	0.001
1) Transfer to intermediate care station	226 (1.9)	118 (1.6)	108 (2.4)	
2) Transfer to ICU	213 (1.8)	123 (1.7)	90 (2.0)	
3) Death	297 (2.5)	174 (2.4)	123 (2.7)	
Discharge to PAC facility – no(%)[b]	2645 (25.2)	1609 (24.5)	1036 (26.3)	0.047

[a] Plus–minus values are means ± SD.
[b] Percentage among 10,509 patients who were candidates to rehabilitation.

6.2%, with a 2.5% mortality rate. Although this mortality rate is similar to the one reported in another handoff study [2], it is lower than the rates found in general internal medicine studies (10%) [16,17]. The significant association between early handoffs and MC (OR = 1.3, P = .012) in our study reflects the findings from previous handoff studies [8,9,18,19]. Denson et al. found that patients who had an end-of-rotation resident transition occurs had a higher mortality rate than those who did not have a rotation transition (OR 1.18, P = .003) [2]. Kuhn et al. showed that patients with early handoffs were more often admitted to the ICU (45% versus 22%, p < .001), but did not find an association between early handoffs and mortality (3.4% versus 2.6%, p = .31) [20]. The absence of significant difference in mortality may be explained by a lack of power (mortality rate was very low) but was more likely related to the use of an electronic health record and chart biopsy process that can prevent medical errors and death.

In our study, patients admitted on holidays and weekends did not differ significantly from weekday admissions. We used an effect modification analysis to explore the effect of weekday versus a weekend or holiday admissions on the association between early handoffs and LOS, as well as the association between early handoffs and MC. This finding contrasts with several prior handoff studies, which reported a "weekend effect," with a significantly longer LOS and a higher mortality rate [21,22]. We propose several contributing factors for our findings. First, on-call teams present all weekend admissions during the Monday morning handoffs. These sessions provide opportunities to exchange key information about the management plans and to anticipate potential problems. We speculate that day teams may be more conscientious when taking over an early handoff patient on Mondays than on other days of the week. Another explanation could be a difference in the type of patients admitted during weekdays and weekends. However, patients' characteristics were globally similar even in terms of co-morbidities or illness severity. Finally, a lack of power could explain the absence of association with week-end admission.

Patients had a mean of 17 blood analyses and two radiology assessments during their hospitalization, which is comparable to prior reports [23]. There was no significant association between early handoffs and use of resources in our dataset, in contrast to two studies conducted over the past two decades [4,24]. This difference may be explained by computerized physician order entry (CPOE) and electronic health record improvements: in our hospital, CPOE allows physicians to prescribe and track all lab and radiology tests. Physicians not only know what has been done but also what has been prescribed (current prescriptions visible), which can help avoid redundant prescriptions.

Nearly a quarter (24%) of patients were transferred to a post-acute

Table 3
Primary outcome – Length of stay (unadjusted and adjusted).

	Length of stay (unadjusted)		Length of stay (adjusted)	
	Effect size (95%CI)[a]	P-value	Effect size (95%CI)[a]	P-value
Early handoff	2.5 (0.3–4.7)	0.023	6.4 (3.5–9.5)	< 0.001
Supervisor switch	11.1 (8.8–13.5)	< 0.001	18.0 (14.8–21.3)	< 0.001
Student involvement	1.2 (−1.2 to 3.6)	0.335	2.1 (−0.1 to 4.3)	0.068
Gender (w)	0.8 (−1.2 to 2.9)	0.424	2.0 (−0.0 to 4.0)	0.049
Age		< 0.001		< 0.001
18–54	Ref.		Ref.	
55–64	13.3 (9.8–17.6)		6.5 (3.2–10.0)	
65–74	23.1 (19.4–27.0)		10.8 (7.6–14.0)	
75–84	26.6 (22.9–30.5)		12.1 (9.0–15.3)	
85+	25.2 (20.9–29.7)		10.2 (6.7–13.9)	
Comorbidities		< 0.001		< 0.001
0	Ref.		Ref.	
1–2	0.2 (−4.4 to 5.0)		1.1 (−3.4 to 5.7)	
3–4	22.3 (16.7–28.1)		18.6 (13.4–24.0)	
5+	58.0 (50.8–65.6)		46.5 (40.1–53.3)	
Couple	−0.04 (−2.4 to 1.7)	0.710	0.1 (−1.8 to 2.1)	0.893
Private sector	11.1 (8.1–14.1)	< 0.001	15.3 (12.4–18.2)	< 0.001
MDRB status	14.2 (11.1–17.4)	< 0.001	7.6 (4.8–10.3)	< 0.001
Previous hospitalization	6.1 (3.9–8.4)	< 0.001	0.9 (−1.0 to 2.9)	0.340
PAC discharge	47.6 (44.2–51.2)	< 0.001	35.5 (32.4–38.7)	< 0.001

There was a significant negative interaction between early handoff and switch of supervisor (p value for the test of interaction < 0.001) indicating that the impact on LOS was weaker when early handoff and switch of supervisor occurred concomitantly compared to early handoff without change of supervisor.
[a] Effect size: % of increase (if positive) or decrease (if negative) in LOS compared to reference category (categorical variables) of by increase of one unit (continuous variables).

Table 4
Secondary outcomes – Use of resources, major complication, post acute care facility discharge (adjusted).

	Use of resources		Major complication		PAC discharge (n = 10,509)	
	Effect size (95%CI)[a]	P-value	OR (95%CI)	P-value	OR (95%CI)	P-value
Early handoff	−0.2 (−3.2 to 2.9)	0.921	1.3 (1.1–1.7)	0.012	0.9 (0.8–1.0)	0.076
Supervisor switch	2.4 (−0.7 to 5.5)	0.135	1.5 (1.2–1.8)	0.001	1.0 (0.9–1.2)	0.681
Student involvement	2.1 (−0.3 to 4.6)	0.088	0.8 (0.7–1.0)	0.055	1.0 (0.9–1.1)	0.909
Gender (w)	−3.2 (−5.2 to −1.1)	0.002	0.9 (0.8–1.1)	0.461	1.1 (1.0–1.2)	0.279
Age		0.009		0.023		< 0.001
18–54	Ref.		Ref.		Ref.	
55–64	0.1 (−3.3 to 3.6)		1.3 (1.0–1.8)		1.8 (1.5–2.2)	
65–74	−2.1 (−5.1 to 1.1)		1.4 (1.1–1.8)		2.3 (1.9–2.8)	
75–84	−4.7 (−7.6 to −1.8)		1.3 (1.0–1.7)		3.5 (3.0–4.1)	
85+	−2.9 (−6.3 to 0.6)		1.6 (1.2–2.1)		4.6 (3.8–5.5)	
Comorbidities		< 0.001		< 0.001		< 0.001
0	Ref.		Ref.		Ref.	
1–2	6.5 (1.4–11.8)		1.2 (0.7–2.2)		0.8 (0.6–1.0)	
3–4	26.7 (20.7–33.1)		2.1 (1.2–3.7)		1.2 (0.9–1.5)	
5+	50.0 (42.7–57.7)		5.6 (3.3–9.7)		2.0 (1.5–2.5)	
Couple	4.2 (2.0–6.4)	< 0.001	1.1 (1.0–1.3)	0.176	0.7 (0.6–0.8)	< 0.001
Private sector	−13.4 (−15.8 to −11.0)	< 0.001	1.5 (1.2–1.8)	< 0.001	0.5 (0.4–0.6)	< 0.001
MDRB status	5.5 (2.6–8.5)	< 0.001	1.7 (1.4–2.0)	< 0.001	1.0 (0.9–1.2)	0.478
Previous hospitalization	−2.8 (−4.8 to −0.7)	0.009	1.2 (1.0–1.4)	0.049	1.3 (1.2–1.4)	< 0.001
PAC discharge	−2.0 (−4.5 to 0.5)	0.121	NA	NA	NA	NA
Length of stay	8.0 (7.8–8.2)	< 0.001	0.97 (0.96–0.99)	< 0.001	1.1 (1.1–1.1)	< 0.001

Goodness-of-fit test: P = .887; P = .999.

[a] Effect size: % of increase (if positive) or decrease (if negative) in LOS compared to reference category (categorical variables) of by increase of one unit (continuous variables).

care facility, which is similar to previous reports [25,26]. We did not find any association between early handoffs and a transfer to a PAC facility. The discharge planning process established in our division several years ago is based on a validated score with 5 variables: patient's partner inability to provide home help, inability to self-manage drug regimen, number of active medical problems on admission, dependency in bathing and in transfers from bed to chair on day 3 [27]. Calculated on day 3 of the admission by the day team in charge of the patient, this score can accurately predict discharge to PAC facility. This plan is discussed with the patient and documented in the patient file. With this process, early handoffs are unlikely to affect the identification of patients potentially requiring a PAC facility transfer.

Our study has several strengths. It is, to our knowledge, the first study to observe and analyze general internal medicine handoffs in a non-US institution, with different laws, regulations and medical education. The use of a sequential, multifactorial algorithm allowed us to identify early handoff patients based mainly on management processes, rather than patient conditions or complexity. In addition, this study was the first to evaluate the impact of handoffs on discharge to a PAC facility and is one of the few studies on the relationship between handoffs and use of resources. Moreover, we included > 11,000 patients, which enabled us to adjust for many covariates, some of which had not been included in prior handoff studies.

Some limitations need to be discussed. First, a retrospective study design may result in potential attribution errors between groups. To limit these errors, we developed a sequential multifactorial algorithm, combining different processes and sources of data. Second, comorbidity data were extracted from medical billing codes. Although these codes may not always include all the patients' diagnoses, the missing diagnoses are unlikely to affect the comorbidity score significantly. Third, even though we found an association between early handoffs and complication rate, the study was not powered to study the association between early handoffs and mortality. Fourth, the definition of our composite outcome for the use of resources was suboptimal, possibly lacking precision to be able to find a significant difference. Finally, we did not have sufficient data for a cost analysis, which could have been interesting in this context.

5. Conclusion

Early handoffs affected the quality of care of internal medicine patients, in particular by increasing the length of stay, particularly for weekday admissions. Since handoffs are unavoidable for continuous care, and that restricting the number of handoffs is unrealistic, we should aim to improve the handoff training for both residents and supervisors, by standardizing the process and content, and evaluate the impact of such changes on the continuity, safety and effectiveness of care for hospitalized patients.

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Prior presentations

The results of this study were presented in the following conferences.

- SGAIM 2017, Basel (CH), 03.05.2017.
- ECIM 2018, Wiesbaden (DE), 30.08.2018.
- WCIM 2018, Cape Town (ZA), 19.10.2018

Ethics approval and consent to participate

The study was conducted at Geneva University Hospitals in accordance with Good Clinical Practice (Declaration of Helsinki 2002). This study was approved on February, 24th 2015 by the institutional ethics committee of Geneva, Switzerland (Project ID 14-255). Patient consent was waived by this committee.

Availability of data and material

The data that support the findings of this study have restrictions and so are not publicly available. Data are however available from the authors upon reasonable request.

Authors' contributions

CF and KB carried out study conception, systematic search, manual search, data retrieval, assessment of risk of bias, analysis, draft of manuscript and revision according to other authors' suggestions, and submission. MLS, JLR and JS carried out analysis and critically revising the manuscript. All authors read and approved the final manuscript.

Declaration of Competing Interest

None.

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