Do mobile hospital teams in residential aged care facilities increase health care efficiency: an evaluation of French residential care policy

Anne Penneau\textsuperscript{1,2} \footnote{Anne Penneau penneau@irdes.fr}

Received: 14 April 2022 / Accepted: 23 August 2022 / Published online: 22 September 2022
© The Author(s), under exclusive licence to Springer-Verlag GmbH Germany, part of Springer Nature 2022

Abstract
Context Patients in residential aged care facilities (RACF) are frequently admitted to hospital since the RACF often lack adequate medical resources. Different economic agents, whose missions and funding may conflict, provide care for RACF residents: residential facility, primary care physicians, and hospital. In this article, I estimate the economic impact of employing a mobile hospital team (MHT) in RACF, which modifies the relationship between these three agents by providing care directly in RACF.

Method A national, patient level database on RACF from 2014 to 2017 is used to calculate RACF outcome indicators. I analyse the difference between RACFs, that use MHT for the first time during the period (treatment group), and those that did not use MHT at all in the same period using a difference in difference (DID) model.

Results The MHT had a significant impact on health care quality in treated RACFs and reduced the number of patients transferred to hospital and the number of emergency department visits, and increased palliative care utilisation at the end-of-life, without increasing total hospital expenditure.

Conclusion MHT appear improve care quality in RACFs by filling the gap in care needs including better end of life care, without increasing health expenditure. Given the high number of hospital transfers especially towards the end of life, securing the right level and mix of social and medical resources in RACFs is essential. Transferring some competencies of MHT teams to residential facilities may improve the quality of life of residents while improving allocative efficiency of public resources.

Highlights
• Mobile hospital teams improve care quality and end of life care in residential care facilities.
• They help to reduce hospital admissions and to develop palliative care.
• This intervention does not increase the costs for public payers.
• Integrating these treatments in residential care funding could improve system-wide efficiency.

Keywords Residential aged care facilities · Mobile hospital teams · Palliative care · Allocative efficiency · Public policy evaluation

JEL Classification I18 · Government policy · Regulation · Public health

Introduction
Residential aged care facilities (RACF) take care of elderly people who have significant health care needs usually towards the end of their lives. While the characteristics of these facilities, sometimes called nursing homes, and their level of medicalization vary widely across countries, they are always on
the frontiers of health and social care systems. The care of residents in RACF involves different economic agents: those in the residential facility, from outpatient care (mainly primary care physician), and from the hospital. These economic agents have different tasks, funding sources, economic incentives, that are sometimes contradictory. The complementarity of these agents, which provide jointly health care for RACFs residents, has been little studied in the literature [1]. The covid-19 pandemic has highlighted, in many OECD countries, the significant deficiencies in the articulation of care between these three main economic agents and the necessity of examining their roles to improve the efficiency of care provision across health and social care sectors [2, 3].

In France, about half of RACF residents are over 87 years old; two-thirds of them have dementia, and three-quarters of the residents live there until end of their life for about median length of stay of 22 months [4]. The RACFs receive funding from the social health insurance (SHI) for ensuring the medical needs of their residents, but the level of medical personnel remains low. The personnel in RACFs are mainly composed of social caregivers (helping with bathing, dressing, meals, activities, etc.) with a few nurses who provide daily nursing care (drug distribution, injections, bandages, etc.). Some facilities have a general practitioner (GP) as care coordinator; although most patients have their own GP and specialists in ambulatory setting or see hospital physicians when necessary.

Many studies examining the public policies to reduce hospitalizations of aged care residents [5–8] suggest that a significant number of hospitalizations can be avoided by better outpatient care [9, 10], but also by increasing the level of personnel with medical skills in RACF [11, 12]. Some studies point to the importance of better coordination of care between RACF and hospital for reducing hospital admissions [13–15]. There is also a growing literature examining the impact of interventions targeting better health care coordination of aged care residents, such as telemedicine [16] or multidisciplinary teams [17, 18]. These teams rarely provide care to the residents themselves, but refer to the involvement of an external, mostly hospital-based, multidisciplinary team to support RACF’s staff with specific expertise on geriatric, palliative, and/or psychiatric care. In this article, I examine a specific French policy which allows mobile hospital teams, called hospital at home (HAH), to provide care in RACF. HAH teams are mostly consisting of a coordinating doctor,1 a coordinating nurse, a nurse practitioner, and a social worker. They provide additional medical and technical resources necessary for some treatments in RACFs to avoid inpatient hospital use.

The intervention of HAH in RACF gives also the possibility for providing palliative care, which is essential for improving the quality of care and avoiding hospitalisations at the end-of-life [19–23]. Palliative care aims to relieve pain and psychological distress, safeguard the dignity of the person, and support his or her entourage but has been developed very little in France since the 1980s [24]. Currently, it is only provided and funded in a hospital setting in France (acute and post-acute care or in HAH). Therefore, extending HAH to residential facilities permits funding palliative care in RACFs.

To evaluate this policy, I use a quasi-experimental (double difference) method, often used in the literature to evaluate non-randomized experiments [25]. The method consists of comparing the evolution of outcome indicators before and after a treatment or intervention between two groups: treated group who had the intervention (here the HAH) and the control groups which did not benefit from the intervention. I expect that utilisation of HAH in RACF would improve the care quality and efficiency of resource use in different ways. First, I expect that there will be a substitution between acute care hospitalisation days and HAH. Using HAH in the facility avoids hospital admissions of residents (inpatient care replaced by HAH). Avoiding hospitalisations, which are always a source of stress, and can deteriorate the health of frail elderly people would improve the quality of life of residents [26]. Second, HAH should reduce total hospital expenditure as the same care in HAH cost less than in acute care hospitals for the SHI. Third, the HAH may help to improve the communication between hospital providers, the primary care physician and RACF personnel, thereby allow better follow up of patients. Hence the introduction of HAH in the facility may avoid some visits to emergency departments. Emergency room visits and emergency admissions to acute-care hospitals are identified in the literature as a great source of stress for the elderly [27]. Finally, the HAH allow the facilities to put in place palliative care which can improve their expertise in end-of-life care. Lack of palliative care at the end of life is recognized as an indicator of poor care quality [19, 28]. I expect that more people benefit from palliative care in RACF which are using HAH.

HAH teams were allowed in RACFs since 2007, but their employment has been very slow since then. Therefore, to evaluate the impact of introducing HAH in RACF, I focus on the facilities who have used HAH as a first time between 2015 and 2017, in other words I consider new users of HAH as treated facilities and the facilities that have never used HAH in this period as control facilities. This empirical strategy aims to estimate the impact of HAH teams in treated facilities on residents’ health care quality and costs. The rest of the article is structured as follows. The next section describes the expected costs and benefits of using HAH teams for RACFs but also for the hospital and the primary

1 Usually, GPs.
care physicians. The data and method presents data and methods used to estimate the impact of HAH on facilities that used HAH teams, result presents the results, limits and sensitivity analysis notes some limitations of this research and presents sensitivity analysis. A last section provides a discussion of the results.

Costs and benefits of HAH teams in residential care

The HAH must be prescribed by an outpatient physician (generally the regular GP of the resident) or by a hospital specialist. To employ HAH, the RACF and the HAH team must first define together a care contract which defines the responsibilities of each. Thus, the use of HAH in RACF will depend on the motivation and financial incentives of these actors to introduce HAH in RACF [29–31]. In this section, I summarize the costs and benefits that may be associated with HAH intervention for the facility, the hospital, the HAH team and the primary care (referring) physician [32, 33].

For RACF, there are more benefits than costs associated with the use of HAH. Although the administrative process to contract with an HAH team can be time-consuming, it would be profitable on several levels. First, the collaboration with an HAH team is encouraged by the Regional Health Agency (ARS) which finances healthcare in these facilities. Second, RACF can potentially gain in revenue by reducing the number of missing days of residents: the amount of the care package paid by the ARS to the RACF is adjusted by the number of days those residents are present. The social care financed by the local authorities and the daily accommodation fees paid by the resident are no longer paid when resident is in hospital more than 4 days. Although it is difficult to know if these rules are applied, in theory, RACFs may have a financial incentive to use HAH which also means having extra medical resources for a patient.

For the HAH providers, RACF represent an important patient pool. However, there is no specific financial incentives for HAH teams to intervene in a RACF, on the opposite, the prices (based on diagnosis related group) are lower when the intervention is in RACF compared to home [29, 32, 33]. For acute care hospitals owning their services, prescribing HAH can be beneficial if the hospital is overcrowding, as it can allow discharging complex patients quicker to RACF after a hospitalization, when the profit margin of HAH is higher. However, they are also paid on their volume of patients (activity-based payment), hence may prefer to have an inpatient stay rather than HAH if they do not have their own HAH services.

For primary care physicians, paid on fee-for-service, HAH is potentially interesting for following their patients. But if the primary care physician has already a large patient base or his involvement in the RACF is weak (few patients in the facility), coordinating HAH can be more time costly than regular patients, which does not require coordination with HAH and RACF.

HAH in RACF necessarily involves collaboration between the HAH team, the person’s primary care physician, and the caregivers in RACF, but also sometimes the hospital physicians when they prescribed the HAH. This interaction between care providers in community, hospital, and RACF can improve care coordination and quality [31] although, it is difficult to measure the cost/benefit ratio of HAH in RACF for these care providers. For all care providers (RACF staff, HAH team and the primary care physician), the need to coordinate care and work together can be costly (administrative burden, differences in culture, hierarchy, etc.) while it can have positive externalities in the long term (improved communication between them, transfer of skills, etc.).

In this article, I assume that the residents do not have an active role in the decision concerning HAH in RACF. While in principle the residents and their family can be involved in care decisions, for example by refusing or proposing HAH, their role is very limited in practice, and the decision concerning HAH in the facility will mainly be made by care providers. Moreover, for the resident, the use of HAH in RACF is financially neutral because it is fully funded by the SHI. However, qualitative studies in France report that there are benefits for the residents since HAH allows residents to stay in a familiar environment with the personnel they know compared to a hospital admission [29–31]. Caregivers of RACF residents can also prefer HAH because they do not have to manage a hospital transfer and they remain in contact with the same care providers in the facility.

Data and method

Data

The analysis is based on patient level claims data from the National health data system (SNDS) matched with the national RACF database for the years 2014 to 2017. The database allows identifying all RACF residents and following their care consumption in different care settings. I used a sample of 12 French regions representative of the population (nearly two-thirds of the elderly population in

---

2 23 euros per day in acute care hospital covered by private complementary health insurance of persons.
France and retained only the RACFs which were present over the entire period of the analysis (from July 2014 to December 2017). The final sample consists of 5373 RACFs that received 696,370 elderly people over the study period.

Overall, five outcome indicators are measured for each semester. The first one, measure acute care hospital utilization, by the number of admissions per 100 RACF residents per semester. Two other indicators, the number of emergency admissions per 100 RACF residents and the number of emergency room visits not followed by hospitalization per 100 RACF residents, are indicators of care quality in RACF. The fourth indicator measures the number of residents who received palliative care at the end of life (in hospital, in post-acute care, or in HAH) per 100 deceased residents per semester. The last indicator is the average total hospital expenditure per resident and per semester. Total hospital expenditure includes expenditure in acute and post-acute care facilities, in HAH as well as expenditure related to emergencies rooms visits and medical transports.

Empirical approach

To estimate the impact of HAH on facilities that used HAH teams, I perform a double-difference analysis (DID) by comparing facilities (RACFs) that made use of HAH for the first time to facilities that did not develop HAH. I assume that after the first use of HAH, these facilities will gain experience in certain medical issues and will continue to use HAH. Using DID, I estimate the impact of this new practice on outcomes indicators. The period studied (between 2014 and 2017) is a period during which HAH in RACFs have been gradually diffused in France. Therefore, I had a good sample of facilities that used it for the first time, with however a fairly large number of facilities that do not use it at all. 2,060 RACFs, 38% of the facilities in the cohort, have not used HAH in the facility for any residents between July 2014 and December 2017. This will be my “control” pool. In the remaining 3313 RACFs that used HAH teams between July 2014 and December 2017, to have a homogeneous treatment group, I identify those facilities which did not have any HAH in the 12 months preceding the first observed HAH. Thus, I exclude the facilities which already used HAH in the second semester of 2014 and the first semester of 2015. I have 1460, 27% of the facilities of the initial cohort, as “new users” between July 2015 and December 2017 which are the “treated” sample. Depending on these treated facilities, the treatment semester (semester of the first use of HAH) can vary from the 2nd semester of 2015 to the 2nd semester of 2017.

The objective of the method is to identify the treated facilities in each semester and year (from the 2nd semester of 2015 to the 2nd semester of 2017) and establish the trends in healthcare consumption before and after this treatment semester. The number of treated facilities selected each semester varies between 412 and 175 facilities. In order to select control facilities in the same period of time (with the same pre- and post-treatment semesters) and avoid the selection bias linked to the semester where treated facilities are identified, I constructed a counterfactual by randomly drawing 4 control facilities for each treated unit from the pool of control facilities (those that have never employed HAH) and give them the same semester of treatment (sometimes referred to as reference semester). For example, in the 2nd half of 2015, there are 412 treated RACFs and 1648 control RACFs (randomly selected from the 2060 RACFs that have never employed HAH) with the same pre-treatment period (from the 2nd half of 2014 to the 1st half of 2015) and the same post-treatment period (from the 2nd half of 2015 to the 2nd half of 2017), while there are 175 treated RACFs and 700 control RACFs (randomly selected) on the 2nd half of 2017 with the same pre-treatment period (from the 2nd half of 2014 to the 1st half of 2017) and one post-treatment period (the 2nd half of 2017). Finally, I identify 1460 treated RACFs and 5840 control RACFs (Fig. 1).

I measure the outcome indicators in the semesters before (T-6, T-5, T-4, T-3, T-2, T-1) and after (T2, T3, T4, T5) the treatment semester (T1). For all the RACFs (1460 treated RACFS and 5840 control RACFs), I observe at least the treatment semester (T1) and the two previous semesters (T-1 and T-2). But the data are censored on the right (T2, T3, T4, T5) and on the left (T-6, T-5, T-4, T-3) depending on the calendar treatment semester of the RACF. For treated and control facilities identified on the 2nd semester of 2015, I can only observe 2 semesters before (T-2, T-1) and 5 semesters after the treatment (T1, T2, T3, T4, T5), while I observe 6 semesters before (T-6, T-5, T-4, T-3, T-2, T-1) and only the first treatment semester (T1) when the treatment is in 2nd semester of 2017. However, the number of treated and control facilities per semester remains sufficiently large over all semesters studied.

To measure the treatment effect with double-difference analysis, I specify a panel linear regression model with facility fixed effects (RACF) as follows:

$$Y_{it} = \alpha + \beta_1 \text{Treat}_i + \beta_2 \text{Post}_t + \beta_3 \text{Treat}_i \times \text{Post}_t + \beta_4 \text{Var}_i + \beta_5 \text{S}_i + \delta_i + \epsilon_{it}$$

where, $Y_{it}$ the outcome indicator in semester $t$ for facility $i$, with $t$ the semester of observation before or after the treatment with $t = -6, -5, -4, -3, -2, -1, 1, 2, 3, 4, 5$ ($t = 1$ corresponds to the treatment semester or reference semester).

---

3 The first semester of 2014 is excluded from the analysis due to poor data quality. The database became representative from mid-2014 onwards.
Do mobile hospital teams in residential aged care facilities increase health care efficiency: \ldots\n
1 3

Treati corresponds to the treated facilities, and Postt is the post-treatment periods introduced in a binary variable with Postt = (0 for semesters before treatment and 1 for semesters after treatment) to estimate the average semester impact at 2.5 years and introduced in a categorial variable to estimate each semester impact Postt = (0 for semesters before treatment and 1, 2, 3, 4, 5 for each semester after treatment). \( \delta_i \) is the facility fixed effect and \( \epsilon_{it} \) is a random term. \( Var_{it} \) corresponds to the characteristics of the facility (RACF) not fixed in time. \( S_{it} \) is the calendar semester of facility i at treatment time t. The coefficient vector \( \beta_3 \) of the interaction term \( Treat_i \times Postt \) measures the difference in trend after treatment between treated and control facilities (estimation of HAH effect on treated facilities). Considering that the data are censored (i.e., I do not observe all pre- and post-treatment value according to treatment semester) to calculate the average treatment impact without overweighted the impact of the first semesters, I weighted the coefficients by treatment semester (or reference semester) with the proportion of censored data.

The introduction of the facility fixed effects allows to control for unobserved characteristics fixed over time between the treated and control facilities, such as, legal status (for profit or not). Characteristics of the facilities, notably the case-mix, which change over time, may also affect the evolution of the outcome indicators. Therefore, the models include three variables to control the variations in the case-mix over time: average age and average number of chronic illnesses of residents by semester and the proportion of residents who died in each semester. I further control for the number of residents in the facility in each semester of analysis as the total number of residents in the facility in any semester vary over time.

Results

Hospital admissions and development of HAH between 2015 and 2017

The number of HAH interventions for RACFs residents per semester nearly doubled between 2015 and 2017 from 0.5 cases per semester per 100 residents to 0.9 cases (Fig. 2). In contrast, in first semester 2015, on average, there were 27 admissions in acute care hospitals per 100 RACF residents of which 16 through emergency department, against 29 admissions and 16 through emergency department in first semester 2017. In addition, in first semester 2015 on average, there were 11 emergency room visits not followed by a hospitalization per 100 residents, against 13 in first semester 2017. The most frequent treatments provided in HAH between 2015 and 2017 were palliative care and complex wound (bedsores, leg wounds, healing problems, etc.), each accounting for about 30% of HAH admissions in RACFs, followed by pain treatment (18% of admissions) and by intravenous treatments (10% of admissions). The proportion of RACFs residents who deceased in palliative care increased slightly between the first half of 2015 and 2017 from 6.1% of those died to 8.1% in the first half of 2017. This is mainly explained by an increase in palliative care in HAH setting, admissions to palliative care in acute or post-acute care hospitals remained constant over the same period.

Treated facilities using the HAH for the first time during the study period had an average of 3.5 HAH admissions per 100 residents the treatment semester (T1) and then an average of one HAH admission per 100 residents in the following semesters (T2, T3, T4, T5) (Fig. 3).
Characteristics of treated and control facilities

Table 1 presents the main attributes of the treated and control facilities. The treated facilities are slightly larger: on average, there were 27 admissions in acute care hospitals per 100 residential aged care facility (RACF) residents, against 29 admissions in first semester 2017. Scope: 5373 French RACFs which were present over the entire period of the analysis. Source: French National health data system (SNDS) claims database (2014–2017).

![Average number of admissions per 100 residents in RACF](image)

**Fig. 2** Number of hospital and palliative care admissions in RACF between the first half of 2015 and 2017. Note: In first semester 2015, on average, there were 27 admissions in acute care hospitals per 100 residential aged care facility (RACF) residents, against 29 admissions in first semester 2017. Scope: 5373 French RACFs which were present over the entire period of the analysis. Source: French National health data system (SNDS) claims database (2014–2017).

![Average number of admissions to HAH (per 100 residents)](image)

**Fig. 3** Number and type of treatments in HAH per 100 residents in treated facilities (for each semester after the first use of HAH). Note: Treated facilities using the HAH for the first time during the study period had an average of 3.5 HAH admissions per 100 residents the treatment semester (T1). Scope: 1460 treated RACFs. Source: French National health data system (SNDS) claims database (2014–2017).

![Number and type of treatments in HAH per 100 residents](image)
but the average age of residents and death rates in treated facilities are slightly higher than in control facilities.

There are significant differences in the level of most pre-treatment outcomes between treated and control facilities.

Impact of HAH use in RACFs on hospital use and expenditure

Tables 2 and 3 present the results of the double-difference model with facility fixed effects and controlling for the differences in case mix and volume of residents in each semester. As expected, the higher morbidity score and age of people living in the RACF are associated with an increase in hospital use and expenditure by residents. Moreover, surprisingly, facilities which have higher death rates use less palliative care for their residents.

In the facilities which used HAH as a first time, the number of admissions in acute care hospital decreased by 2 admissions per 100 residents per semester over the two and a half years following the first utilisation (Table 2). The admissions to emergency department are significantly declined in treated facilities: on average one emergency admission and one emergency room visit less per 100 residents each semester over the two and a half years following the first use of HAH. The number of residents at the end of life who were managed by a palliative care team increased by 4 percentage point per semester following the first HAH intervention in the treated facilities compared to the control facilities. This doubles the number of palliative care deaths in treated facilities over the study period.

Figure 5 gives the HAH effect on treated facilities by semester after the first utilisation (T1, T2, T3, T4, T5). The acute hospital use, emergency admissions and emergency rooms visits were not significantly different in the first semester of HAH use between treated and control facilities, but there is a significant reduction from the second semester onwards with a higher effect in each semester, ranging from a reduction of 2,2 acute care admissions, of 1,2 emergency admissions and 0,8 emergency rooms visits in the second semester to a reduction of 3,8 acute care admissions, of 2,4 emergency admissions and 1,9 emergency rooms visits in the fifth semester. For palliative care, the increase is more significant in the first semester (T1), and it remains stable over the following semesters, with an increase of about 3.5 palliative care use per 100 residents died.
Table 3 gives the results on total health expenditure of residents by care settings. The average expenditure per semester over the two and a half years following the first HAH intervention was significantly reduced by 60 euros per semester and resident in the treated compared to control RACFs. Thus, on average over the two and a half years following the first HAH, acute care expenditure is reduced by 80 euros per semester, emergency rooms expenditure is reduced by 5 euros per semester and per resident, and transport expenditure is reduced by 15 euros per semester and
Do mobile hospital teams in residential aged care facilities increase health care efficiency?:…

1.3 per resident, while HAH increased the expenditures by 43 euros per semester and per resident. There is no significant variation in post-acute care expenditures (Fig. 6).

**Limits and sensitivity analysis**

I should note some limitations of this analysis. First, the impact of the treatment may vary according to treatment dates and HAH teams may become more/less efficient over time. Recent literature pointed out that using a fixed-effect regression model to estimate DID may introduce measurement bias with heterogenous treatment effects [34, 36]. To test the heterogeneity of treatment effect according to treatment semester, I produced separate analysis for each treatment semester (from 2nd semester of 2015 to 2nd semester of 2017). The results are consistent despite data censoring, which seems to indicate homogeneity of the effects of HAH according to the semester treatment. I also applied the corrections proposed by Callaway & Sant'Anna [36] as well as De Chaisemartin & D'Hautfoeuille [35]. The results are mainly coherent with a few differences (Table 3, Figs. 1 and 2 in the online appendix). The correction of negative weights with the method of De Chaisemartin and D'Hautfoeuille resulted in increasing the magnitude of impact coefficients while the impacts are slightly lower with the method of Callaway & Sant'Anna. However, in both methods’ estimation of difference in trends before treatment is significant except for the palliative care outcome with

| Table 2 Impact of the HAH in RACF on residents’ hospital use: results from DID estimations |
|---------------------------------------------------------------|
| Estimated effect of HAH use (mean semester effect after 2.5 years) | (mean semester effect after 2.5 years) |
| No of admissions to acute care hospital (per 100 residents) | -1.984*** |
| (0.338) |
| No of emergency admissions (per 100 residents) | -1.259*** |
| (0.233) |
| No of emergency room visits (per 100 residents) | -1.090*** |
| (0.221) |
| No of palliative care stays (per 100 death) | 4.377*** |
| (0.380) |

**Control variables**

| Number of residents | -0.017** |
| (0.008) |
| Mean age of residents | 0.105* |
| (0.058) |
| Average co-morbidity score of residents | 7.625*** |
| (0.503) |
| Average death rate of residents (in %) | 37.774*** |
| (2.000) |

**Semester calendars (reference 2nd half of 2014)**

| 1st half of 2015 | 0.397** |
| (0.191) |
| 2nd half of 2015 | 0.023 |
| (0.217) |
| 1st half of 2016 | 4.610*** |
| (0.355) |
| 2nd half of 2016 | 3.101*** |
| (0.386) |
| 1st half of 2017 | 4.750*** |
| (0.441) |
| 2nd half of 2017 | 3.252*** |
| (0.446) |
| Constant | 0.631 |
| (5.239) |
| R-square | 0.064 |
| (2.345) |

Note: In the facilities which used HAH as a first time, the number of admissions in acute care hospital decreased by 1.6 admissions per 100 residents per semester over the two and a half years following the first utilisation.

Scope: 7300 French RACFs, 1460 treated and 5840 control RACFs (randomly selected), see the empirical approach section for more details.

Source: French National health data system (SNDS) claims database (2014 –2017)

*, **, and *** indicate 10%, 5% and 1% significance, respectively. Standard error in brackets.
the two methods\(^4\) and total hospital expenditure with De Chaisemartin & D’Hautfoeuille estimation (Table 3 in the appendix). The results are therefore robust for the rise in palliative care. The results on hospitalizations (use and expenditure) are less robust because the trends are not perfectly parallel before treatment. However, the reduction after treatment is observed by all estimation methods and the impact increases over time (see Figs. 1 and 2 in the online appendix). In addition, the higher variation observed in semesters before treatment after the application of the negative weight correction methods might be partly explained by the reduction in the number of observations linked to these methods, leaving few observations at the extreme dates (where there are a lot of censored data) and therefore averages can be drawn easily by extreme values.

Second, the difference-in-difference model estimate the impact of HAH used on treated facilities, which questions the external validity of my results. The external validity can be examined by the selection effect linked to my treatment. If the treatment studied is exogenous, the results found can be extrapolated to all the facilities but if there is a selection effect of treated facilities, these results are only valid for this selection of facilities and might change to other facilities. The treated facilities identified seem to have different characteristics: they have higher numbers of hospital and emergency admissions than control facilities without any difference in palliative care utilisation before treatment.

\(^4\) Significant at 10% with Callaway & Sant’Anna estimation.
Do mobile hospital teams in residential aged care facilities increase health care efficiency:…

may suggest that lower performers were more likely to adopt HAH or the case-mix of the facilities is different. Nevertheless, the RACF do not decide by themselves to use HAH, the decision is made by the GP sometimes with a prescription from a hospital physician. Therefore, both willingness of GPs to prescribe or accept HAH for their patients and the characteristics of the HAH teams providing can be important determinants of HAH treatment selection. The geographical location may also be linked to the selection of these facilities (if the facilities are located near a HAH team which provide care in RACFs). These explain why HAH mayn’t be available to everyone and differences in treated RACFs characteristics but does not necessarily challenge the results in the sense if they could have HAH the impact might be the same as RACF do not decide themselves to provide HAH. However, it cannot be excluded that the impact would be different if GPs or hospitals that could not or did not wish to provide HAH were encouraged to provide it (through incentive policies). Indeed, there may be differences in HAH impact between professionals who take over a procedure by themselves and professionals who are pushed to use it, or if they provide the same care in more difficult conditions (in facilities away from them, with less interaction and collaboration, etc.).

Discussion

Residential facilities care for elderly people with multiple care needs. The lack of adequate medical competencies in RACFs results in hospital transfers, which are costly, and have negative consequences on mental and physical health of the elderly people. To reduce repeated hospitalisations and provide better care for older persons in RACFs, the French government authorized HAH teams to provide certain treatments in RACFs. In this study, I estimate the economic impact of employing HAH in RACFs and show that facilities

5 Some HAH teams do not provide care in RACFs, while others are more specialized in this type of care.
that use HAH for the first time between 2015 and 2017 have a positive change in quality indicators without increasing the costs of care for the public payer. The results of this analysis suggest that the task distribution between different economic agents providing care for these elderly people may not be the optimum. Supporting RACFs to provide certain types of medical care, especially the end-of-life care, can improve systemwide efficiency.

In 2017, there were on average 40 hospitals acute care admissions for 100 persons aged 80 and over in France, while there were 58 admissions for 100 residents in RACFs [37]. Reducing hospital transfers for these vulnerable populations is a care quality and efficiency issue in all OECD countries. This article questions the impact of mobile hospital teams in RACFs on hospital transfers and shows that on average hospital admissions deceased by 2 admissions per semester in the two years and a half following the first HAH intervention. Results are consistent with the literature showing that interventions from multidisciplinary teams in residential aged care facilities can reduce hospital transfer of residents [17, 18]. Multidisciplinary mobile team in RACFs proves to be an interesting tool as it requires collaboration and medical consultation between many care providers from various care sectors. The result obtained on the reduction in the number of emergency visits in treated facilities, seems to indicate that the improvement in care is not only linked to a substitution of care between acute care and HAH but possibly to better follow-up of patients which can reduce emergency visits.

The impact of HAH intervention on outcomes (reduction of hospital transfer and emergency visits) appear to increase over time. This is not the results of an increase in the HAH utilization in RACFs over time since the number of HAH admissions remain constant in the four semesters following the first HAH used in the facility. The increase in impact over time could be linked to a cumulative learning effect in RACF or HAH becoming more effective over time within a RACF. The learning effect may come from knowledge sharing between HAH teams and nurses in RACF, on common care issues such as complex dressings.

Fig. 6 Results of the impact of the use of HAH in RACF in treated facilities on residents’ hospital expenditures per semester. Scope: 7300 French RACFs, 1460 treated and 5840 control RACFs (randomly selected), see the empirical approach section 2 for more details. Source: French National health data system (SNDS) claims database (2014–2017)
for example. This means that the RACF nurses will be able to manage alone some situations which could reduce hospital use without increasing admission to HAH. Therefore, an increase in HAH impact over time in treated facilities could be explained by a combination of the medium-term effect of the first residents treated in the first semester and the short-term effect of the new residents treated in the following semesters.

However, both at home and in institution, the number of HAH admissions seem relatively low compared to the number of hospital transfers. There is less than one HAH admission per 100 people older than 80 in the general population and less than two admissions for 100 residents in RACFs in 2017 [38]. The demand for HAH may be linked to multiple factors not directly related to the care needs of older adults living at home or in institution, such as disparities in geographical access to HAH teams and the financial incentives for RACF and other care providers in investing in HAH versus sending patients to hospital. Both increasing accessibility and incentives to provide HAH care are public policy levers that can be used to increase HAH utilisation in RACFs. Few policy incitive has been put in place in the last ten years in France, except the expansion of the list of treatments that can be provided by HAH teams in RACFs and a few increases in HAH prices for HAH teams (without modifying the lower prices in RACF compared to home interventions). Another barrier to the development of HAH teams is the lack of availability and implication of self-employed GPs to provide this care in RACFs in collaboration with the HAH.

The results of this study show that there is a significant increase in palliative care in RACFs linked to HAH. Indeed, palliative care utilisation is doubled in facilities using HAH in the two years and a half after a first HAH utilisation. This result suggests a significant improvement in the quality of end-of-life care for residents of these facilities. However, the inequality in access to HAH questions the equity in end-of-life care quality for all residents in France. This challenges the capacity of incentive policies and supply regulation to reduce the facilities selection effect linked to their GPs and hospital characteristics and ensure equity in access to HAH teams for all French facilities.

Overall, these results highlight the need to examine the optimal management and funding of end-of-life care in RACFs. As palliative care is exclusively funded in hospital settings in France, HAH teams are the only alternative for providing palliative care by a multidisciplinary team outside hospitals. There are other hospital mobile teams specialised in palliative care in France which intervene in RACFs, but they do not provide care directly to residents; they give advice to the staff in RACF to support their end-of-life practises and for difficult situations. The GPs can also support a palliative approach and prescribe treatments for pain. However, it is generally recognized that there is a lack of palliative care culture among GPs and staff in RACFs in France [24] even though more than half of deaths in RACFs would require palliative support [39, 40]. This study shows that more than 90% of residents who died in RACFs did not have palliative care. Specific care needs at the end-of-life are not considered in RACFs funding in France. Some countries, such as Japan, adjust the payments to RACFs for the last days of life of residents to account for the costs of specific care at the end of life [41]. To reduce hospital transfers, it may be more efficient to integrate end-of-life care needs in RACF funding to help them invest in medical and social resources and upscale competencies to increase end-of-life quality for all facilities and residents, while mobile hospital teams, as HAH, can be used in the most complex care needs.

This study shows the interest of HAH teams to improve care in RACFs and more broadly provides new evidence for reconsidering the skill-mix and funding model of residential aged care facilities in France. Aligning economic incentives and care responsibilities between health and social care providers is essential everywhere for achieving better care models for an aging population in a sustainable way.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s10198-022-01522-1.

Acknowledgements I would like to thank my PhD advisor Zeynep Or, for her constructive suggestions and editing comments that helped to significantly improve the previous version of this article.

Funding This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Availability of data and material All data and materials as well as software application or custom code support published claims and comply with field standards.

Code availability Not applicable.

Declarations

Conflict of interest None.

References

1. Grabowski, D.C., Caudry, D.J., Dean, K.M., Stevenson, D.G.: Integrated payment and delivery models offer opportunities and challenges for residential care facilities. Health Aff. 34(10), 1650–1656 (2015)
2. Menéndez-Colino, R., Argentina, F., de Miguel, A.M., Barcons Marqués, M., Chaparro Jiménez, B., Figueroa Poblete, C., Alarcón, T., Martínez Peromingo, F.J., González-Montalvo, J.I.: La Geriatría de Enlace con residencias en la época de la COVID-19 Un nuevo modelo de coordinación que ha llegado para quedarse [Liaison geriatrics with nursing homes in COVID time A new coordination model arrived to stay]. Rev. Esp. Geriatr.
7. Intrator, O., Zinn, J., Mor, V.: Nursing home characteristics and potentially preventable hospitalizations of long-stay residents. J. Am. Geriatr. Soc. 52, 1730–1736 (2004)

8. Grøverholt, B., Forsetlund, L., Jamtvedt, G.: Reducing hospital admissions from nursing homes: a systematic review. BMC Health Serv. Res. 14(1), 1–8 (2014)

9. Lloyd, T., Conti, S., Santos, F., Steventon, A.: Effect on second-care of providing enhanced support to residential and nursing home residents: a subgroup analysis of a retrospective matched cohort study. BMJ Qual. Saf. 27(5), 534–546 (2019)

10. McDermott, C., Coppin, R., Little, P., Leydon, G.: Hospital admissions from nursing homes: a qualitative study of GP decision making. Br. J. Gen. Pract. 62(601), e538–e545 (2012)

11. Kwa, J.M., Storer, M., Ma, R., Yates, P.: Integration of inpatient and residential care in-reach service model and hospital resource utilization: a retrospective audit. J. Am. Med. Dir. Assoc. 22(3), 670–675 (2021)

12. Szczepura, A., Nelson, S., Wild, D.: In-reach specialist nursing teams for residential care homes: uptake of services, impact on care provision and cost-effectiveness. BMC Health Serv. Res. 8(1), 1–15 (2008)

13. Fan, L., Hou, X.Y., Zhao, J., Sun, J., Dingle, K., Purtilt, R., Lukin, B.: Hospital in the Nursing Home program reduces emergency department presentations and hospital admissions from residential aged care facilities in Queensland, Australia: a quasi-experimental study. BMC Health Serv. Res. 16(1), 1–9 (2015)

14. Harvey, P., Storer, M., Berlowitz, D.J., Jackson, B., Hutchinson, A., Lim, W.K.: Feasibility and impact of a post-discharge geriatric evaluation and management service for patients from residential care: the Residential Care Intervention Program in the Elderly (RECIPe). BMC Geriatr. 14(1), 1–9 (2014)

15. Hullick, C., Conway, J., Higgins, I., Hewitt, J., Dilworth, S., Holdiday, E., Attia, J.: Emergency department transfers and hospital admissions from residential aged care facilities: a controlled pre-post design study. BMC Geriatr. 16(1), 1–10 (2016)

16. Groom, L.L., McCarthy, M.M., Stimpfel, A.W., Brody, A.A.: Telemedicine and telehealth in nursing homes: an integrative review. J. Am. Med. Dir. Assoc. 22(9), 1784–1801 (2021)

17. Nazir, A., Unroe, K., Tegeler, M., Khan, B., Azar, J., Boustani, M.: Systematic review of interdisciplinary interventions in nursing homes. J. Am. Med. Dir. Assoc. 14(7), 471–478 (2013)

18. Lau, L., Chong, C.P., Lim, W.K.: Hospital treatment in residential care facilities is a viable alternative to hospital admission for selected patients. Geriatric Gerontol. Int. 13(2), 378–383 (2013)

19. Froggatt, K.A., Moore, D.C., Van den Block, L., Ling, J., Payne, S.A., Arrue, B., Vernooij-Dassen, M.: Palliative care implementation in long-term care facilities: European Association for Palliative Care White Paper. J. Am. Med. Dir Assoc. 21(8), 1051–1057 (2020)

20. Luka, J.K., Chan, F.H.: End-of-life care for advanced dementia patients in residential care home—a Hong Kong perspective. Ann. Palliat. Med. 7(3), 359–364 (2017)

21. Tropea, J., Johnson, C.E., Nestel, D., Paul, S.K., Brand, C.A., Hutchinson, A.F., Lim, W.K.: A screen-based simulation training program to improve palliative care of people with advanced dementia living in residential aged care facilities and reduce hospital transfers: study protocol for the IMProvE Palliative care Education and Training Using Simulation in Dementia (IMPE-TUS-D) cluster randomised controlled trial. BMC Palliat. Care 18(1), 1–11 (2019)

22. Chapman, M., Johnston, N., Lovell, C., Forbat, L., Liu, W.M.: Avoiding costly hospitalisation at end of life: findings from a specialist palliative care pilot in residential care for older adults. BMJ Support. Palliat. Care 8(1), 102–109 (2018)

23. Hui, E., Ma, H.M., Tang, W.H., Lai, W.S., Au, K.M., Leung, M.T., Woo, J.: A new model for end-of-life care in nursing homes. J. Am. Med. Dir. Assoc. 15(4), 287–289 (2014)

24. Bohic N., Fellinger F., Saie M., Vioo lsat LC.: Évaluation du plan national 2015–2018 pour le développement des soins palliatifs et l’accompagnement en fin de vie. Rapport de l’Insp. Gen. Des Aff. Soc. (Igas) 2018–140R. juillet 2019.

25. Wing, C., Simon, K., Bello-Gomez, R.A.: Designing difference in difference studies: best practices for public health policy research. Annu. Rev. Public Health. 39(1), 453–469 (2018). https://doi.org/10.1177/1077558707308754

26. Boyd, C.M., Landefeld, C.S., Counsell, S.R., Palmer, R.M., Fortinsky, R.H., Kresvic, D., Burant, C., Covinsky, K.E.: Recovery of activities of daily living in older adults after hospitalization for acute medical illness. J. Am. Geriatr. Soc. 56(12), 2171–2179 (2008)

27. Aminzadeh, F., Dalziel, W.B.: Older adults in the emergency department: a systematic review of patterns of use, adverse outcomes, and effectiveness of interventions. Ann. Emerg. Med. 39, 238–247 (2002)

28. Dwyer, R., Gabbe, B., Stoelwinder, J.U., Lowthian, J.: A systematic review of outcomes following emergency transfer to hospital for residents of aged care facilities. Age Age. 43(6), 759–766 (2014)

29. Robillard, J.: La fédération de l’HAD appelle à une "réforme en urgence" de sa tarification. Hospimedia; https://abonnés.hospimedia.fr/articles/20200716-finance-la-federation-de-l-had-appelle-a-%5Bt%5D&utm_source=https%3A%2F%2Fwww.hospimedia.fr%2Factualite%2Farticles%2F20200716-finance-la-federation-de-l-had-appelle-a%5Bu%5D_medium=publicSite&utm_campaign=redirection&utm_term=logged (2020). Accessed 11 Sept 2022

30. Hoffmann M.: Profil des médecins généralistes utilisant l’hospitalisation à domicile en établissement d’hébergement pour personnes âgées dépendantes. Exemple messin (Doctoral dissertation, Université de Lorraine). 2012.

31. de Stampa, M., Andrieu, M., Chataux, S., Clément, E., Costes-Henri, B., Leforestier, E., Sablonnières, S.: Hospitalisation à domicile et malades âgés. Neurol. Psychiatr. Gériatr. 83, 265–269 (2014)

32. Durand N., Lannelongue C., Legrand P., Marsala V.: Hospitalisation à domicile (HAD). Rapport de l’Inspection générale des Affaires sociales (Igas). N°RM2010–109P, novembre 2010.

33. Cours des comptes, 20 janvier 2016. https://www.legifrance.gouv.fr/codes/article_lc_20160101_lc_000000229322.texte (2020). Accessed 11 Sept 2022

34. Goodman-Bacon, A.: Difference-in-differences with variation in treatment timing. J. Health Econ 225(2), 254–277 (2021)
35. De Chaisemartin, C., D’Haultfoeuille, X.: Two-way fixed effects estimators with heterogeneous treatment effects. Am. Econ. Rev. 110(9), 2964–2996 (2020)
36. Callaway, B., Sant’Anna, P. H.: Difference-in-differences with multiple time periods. J. Econom. 225(2), 200–230 (2021)
37. ATIH. Analyse de l’activité hospitalière 2017. https://www.atih.sante.fr/sites/default/files/public/content/3478/synthese_aah_2017.pdf. Accessed November 2018
38. ATIH. Hospitalisation à domicile : Chiffres clés 2017. https://www.atih.sante.fr/sites/default/files/public/content/2554/atih_chiffres_cles_had_2017.pdf. Accessed 29 June 2018
39. Ferley J.P., Roche-Bigas B., Stamane I., Lacroix A. : Prise en charge de la fin de vie en EHPAD en Nouvelle-Aquitaine. Une étude de l’ARS Nouvelle-Aquitaine. Rapport 29, mai 2018
40. ONFV : Fin de vie des personnes âgées : Sept parcours ordinaires pour mieux comprendre les enjeux de la fin de vie en France. Observatoire de la fin de vie, Rapport 2013.
41. Barber SL., van Gool K., Wise S., Wood M., Or Z., Penneau A., & Lorenzoni L.: Pricing long-term care for older persons. World Health Organization. 2021.

Publisher’s Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Springer Nature or its licensor holds exclusive rights to this article under a publishing agreement with the author(s) or other rightsholder(s); author self-archiving of the accepted manuscript version of this article is solely governed by the terms of such publishing agreement and applicable law.