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INNOVATIVE TOOLS AND METHODS

Short Report

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Effectiveness of a digital telemonitoring platform for cancer care of older patients: The *ConnectElderlyPatientToDoctor* study

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Abstract

While telemedicine has been shown to improve the quality of care for cancer patients, it remains underused for older patients (OP), partly due to the assumption that OPs are unabled or unwilling to use digital tools. However, more than 50% of new cancers are diagnosed in people over 70. The *ConnectElderlyPatientToDoctor* study aimed to evaluate the OP compliance with the use of the digital telemonitoring platform Cureety in oncology. All cancer patients followed at the Military Hospital Bégin were eligible for the study. Patients were invited to respond to a symptomatology questionnaire personalized to their pathology and treatment. An algorithm evaluated the health status of the patient based on the reported adverse events. The population was divided into two groups, OP and younger patients (YP), based on a cut-off at 70 years. The primary endpoint was to assess the compliance of OPs with the use of the digital oncology platform Cureety, compared to YP. From July 2020 to September 2021, a total of 117 patients were included in our study. We found that 66% of the patients were compliant, with no difference between the two groups (71.2% of YP, 61.7% of OP, $P = .29$). In OPs, progression free survival (PFS) ratio at 6-months was 64.6% in the tolerant patients vs 23.4% in the nontolerant patients (HR = 0.1980, 95% CI = 0.04431-0.8845, $P = .0339$). The median PFS was 23.3 months in the tolerant group vs 3.3 months in the nontolerant group ($P = .0339$). The data of overall survival are immature. OPs had a clear benefit from using this platform, similar to what was observed for YP. Patients felt less isolated and felt that they benefited from personalized care with early ambulatory medical care of adverse events. We also found that the health indicators collected with the platform in the first month of treatment are predictive of the progression of the disease. This solution makes it possible to streamline and improve the care pathway of OP.

KEYWORDS
older cancer patients, quality of life, telemonitoring

Abbreviations: AE, adverse event; CNIL, Commission nationale de l'informatique et des libertés; CTCAE, Common Terminology Criteria for Adverse Events; ePRO, electronic Patient Reported Outcome; OP, older cancer patients; OS, overall survival; PFS, progression free survival; YP, younger cancer patients.

What's new?

Telemedicine has been shown to improve the quality of care for cancer patients. However, telemedicine remains underused for older patients, partly due to the assumption that they are unable or unwilling to use digital tools. Here, the authors demonstrate that telemonitoring is indeed accessible and beneficial to older patients. While using the platform, patients felt less isolated and that they benefited from personalized care. Moreover, the health indicators collected through the platform in the first month of treatment were predictive of disease progression. Telemedicine makes it possible to streamline and improve the care process of older cancer patients.

1 | INTRODUCTION

Cancer in older individuals is a major public health challenge in countries with an aging population, as cancer incidence increases with age. In France, one third of the individuals that are 70 or older have cancer.[1] Taking care of older patients in oncology must be multidisciplinary, multidimensional and personalized, by taking into account their frailty.[2] Moreover, medical care cannot be based only on the chronological age of the patients, but also on their "physiological" age, that includes their medical history, the lack of reserve, and geriatric syndromes (https://context.reverso.net/traduction/anglais-francais/geriatric+syndromes), such as frailty.[3]

Telemedicine has a clear potential to improve the care of our patients, especially OPs, by maintaining a continuous link with them and monitoring adverse events. In fact, the benefits of telemonitoring for cancer patients are well established, improving their quality of life[4] and survival,[5] while reducing the cost of care.[6] In the case of OPs, telemonitoring has been shown to improve the survival and to reduce the hospitalizations in the context of diabetes or cardiovascular diseases.[7-9] In the present study, we demonstrate that the use of telemonitoring is indeed accessible to OPs and that it could be used as a predictive indicator of survival, through the measurement of the early tolerance status of the patients.

The known benefits of telemonitoring include the early and real-time detection of illnesses, complications, relapses, treatment toxicities and untimely deaths, a reduction in the number of hospitalizations and their cost, more accurate information on the patient health without interfering with their daily activity, and improved efficiency of healthcare services and emergency medical care.[10] The collection of patient-reported outcomes (PROs) as part of telemonitoring enables a more accurate evaluation of the patient's experience of a disease, allowing informed adjustments to the treatment in order to improve tolerance and compliance. It also improves the communication between the health practitioners and the patients.

While the benefits of telemedicine are well established, it is underused in older cancer patients. The barriers that prevent the adoption of telemonitoring as part of the care pathway have not all been identified, but they include prejudices against OPs and their supposed inability or unwillingness to use digital tools. In order to assess the feasibility of telemonitoring for OPs with cancer, the *ConnectElderlyPatientToDoctor* study aimed to evaluate the compliance with the use of a digital telemonitoring platform Cureety as part of their care.

2 | PATIENTS AND METHODS

The *ConnectElderlyPatientToDoctor* study is a prospective study, conducted in the Clinical Research Unit in Military Hospital Bégin.

2.1 | Patients

The study ran from July 1, 2020 until September 30, 2021. All cancer patients treated at the Military Hospital Bégin were eligible for the study. There were two exclusion criteria: patients that did not agree to the use of a digital telemonitoring tool, and minors (17-year-old or less). Patients were included at the time of a hospital visit, as long as they were receiving an antitumoral treatment. Patients with internet access via their smartphone or via a computer were included in the "telemonitoring" cohort. Patients without internet access or with little digital autonomy were included in the "call session" cohort and were contacted by telephone at regular intervals to answer the personalized questionnaire they were assigned.

2.2 | Study design

Each cancer patient was allowed to respond to a personalized symptomatology questionnaire personalized to their pathology and treatment, using a digital telemonitoring platform called Cureety. The platform has been used as part of routine care at this hospital since July 2020, as described previously.[11] In short, the questionnaires follow the CTCAE (Common Terminology Criteria for Adverse Events) to grade adverse events (AEs) relevant to the patient's pathology and treatment.[12] Patients have access to the platform at all time, and can answer any time of day, on their own schedule, up to once a day. They are prompted to answer at least once a week, or once every 2 weeks, depending on their treatment.[11] For each completed questionnaire, a global health score is computed by an algorithm to classify the

patients into one of four different states: Correct (green), Compromised (yellow), To be monitored (orange) or Critical (red). Patients are not shown the classification or its color directly, but in the case of green or yellow states, the patients received only therapeutic recommendations to manage their AEs. In the case of orange or red states, the patients received therapeutic recommendations and were invited to call the hospital or their general practitioner.

For the purpose of our study, we computed two endpoints: "compliance" and "first-month tolerance." Compliance to the digital telemonitoring tool, which indicates whether the patients respond to their digital questionnaires at the expected frequency (once every 1 or 2 weeks), was assessed as previously described.[11] First-month tolerance indicates whether the patient tolerates the treatment during the first 30 days. For this, we calculated the number of days when the patient's health classification was green or yellow (count A), and the number of days when it was orange or red (count B), ignoring days when the patient had not answered at the expected frequency (state unknown). The counts were assessed for the first 30 days of treatment, to compute the first-month tolerance. The patients were classified as "tolerant" when A was higher than B, and otherwise "nontolerant."

The population was divided into two groups: OPs and YPs, based on a cut-off at 70 years. Our study was divided into two parts: (1) the description of the overall population; (2) a matched exposed-unexposed study to specifically assess the impact of age on the compliance with the use of the Cureety platform. OPs were matched with YPs based on the primary tumor site. The primary endpoint was compliance with the use of the digital telemonitoring platform Cureety. The secondary endpoint was a comparison between the following outcomes in the OP and YP groups: first-month tolerance, number of unscheduled hospitalizations, and correlation between first-month tolerance and progression free survival (PFS).

2.3 | Data collection and measurements

We collected demographic data (age at inclusion, sex, comorbidities, weight, height), disease characteristics (primary site, histology, stage at platform's inclusion [according TNM classification], molecular biology), treatment characteristics (type, duration), inclusion in a clinical trial. The individual AEs, the grades reported by the patients, as well as the global health status were collected through the telemonitoring digital tool Cureety. The number of unscheduled hospitalizations were collected from the patient's medical records. The missing data points were: compliance to the protocol study for five patients, tolerance for one patient, stage at diagnosis for two patients, progression of cancer for six patients and vital status for one patient.

2.4 | Statistical analysis

Differences between patient groups were assessed using the unpaired Student's *t*-test and Mann-Whitney *U* test for continuous covariates or the chi-square test for categorical covariates. Survival probabilities were estimated by the Kaplan-Meier method. PFS was defined as the time from inclusion to progression; and overall survival (OS) was defined as the time from inclusion to all-cause death. All statistical analyses were carried out with Statview software (SAS Institute, Cary, NC). All tests were two-tailed, and *P* values lower than .05 were considered significant.

3 | RESULTS

3.1 | Patient characteristics

From July 2020 to September 2021, a total of 117 patients were included in our study, with 61 OPs (52%) and 56 YPs (48%). In the OPs, the median age was 78 (range 70-99). In this group, 47 (77%) were male and 60% presented at least one comorbidity. There was a broad range of primary tumors including prostate (67.2%), lung (14.8%) and breast (9.8%), with 82% of the patients presenting with an advanced disease. Thirty-four (56%) received new hormonal therapy, 18 (15%) received chemotherapy and 5 (8%) received immunotherapy.

Baseline characteristics are summarized in Table 1.

3.2 | Patient-reported outcomes on AEs

Out of 4753 ePRO questionnaires completed by the patients, 64% (n = 3048) corresponded to a "correct" state, 26% (n = 1219) to a "compromised" state, 9% (n = 439) to a state "to be monitored" and 1% (n = 47) to a "critical" state (Figure 1). In the OP group, 2299 ePRO were completed. In this group, there were more reports resulting in correct states, with 89% (n = 2036) corresponding to a "correct" or a "compromised" and only 11% (n = 263) corresponding to a state "to be monitored or critical" (Figure 1).

3.3 | Compliance

After a median follow-up of 8 months, 66% of the patients were found to be compliant with the use of the telemonitoring digital platform. There was no difference between the groups in terms of compliance (Table 2:71.2% of YPs, 61.7% of OPs, $P = .29$).

3.4 | Tolerance

Based on observations from our practice, we hypothesized that the tolerance profile of the patients could be an early indicator of treatment impact and the progression of the disease. We thus calculated the tolerance of patients during their first month of treatment, based on the health classification computed by the telemonitoring tool (see Section 2). Among the OPs, 61.7% were tolerant, compared to 71.2% for the YPs. There was no significant difference between the two groups (Table 2: $P = .29$).

TABLE 1 Baseline patients' characteristics

Variables	All patients	<70	≥70	*P* value
Number of patients n, (%)	117 (100)	56 (47.9)	61 (52.1)	–
Gender N, (%)				
Female	34 (29.1)	20 (35.7)	14 (23.0)	.13
Male	83 (70.9)	36 (64.3)	47 (77.0)	
Age (median, range)	70.0 (30.0-90.0)	62.0 (30.0-69.0)	78.0 (70.0-99.0)	–
Comorbidities n, (%)				
Cardiovascular	67 (59.3)	26 (57.8)	41 (60.3)	
Pulmonary	10 (8.8)	3 (6.7)	7 (10.3)	.02
Renal	6 (5.3)	3 (6.7)	3 (4.4)	
Other	30 (26.6)	13 (28.8)	17 (25.0)	
Primary site				
Prostate	61 (52.2)	20 (35.7)	41 (67.2)	
Lung	28 (23.9)	19 (33.9)	9 (14.8)	
Breast	15 (12.8)	9 (16.1)	6 (9.8)	.01
Others gyneco-urinary cancers	11 (9.4)	6 (10.7)	5 (8.2)	
Others cancers	2 (1.7)	2 (3.6)	0 (0.0)	
Stage				
Localized disease	18 (15.7)	7 (12.7)	11 (18.3)	.41
Advanced disease	97 (84.3)	48 (87.3)	49 (81.7)	
Type of treatment n, (%)				
Chemotherapy	42 (36.2)	24 (43.6)	18 (29.5)	
Hormonotherapy	47 (40.5)	13 (23.6)	34 (55.7)	.003
Immunotherapy	18 (15.5)	13 (23.6)	5 (8.2)	
Combined treatment	9 (7.8)	5 (9.2)	4 (6.6)	
Clinical trial				
No	72 (63.2)	33 (60.0)	39 (66.1)	.50
Yes	42 (36.8)	22 (40.0)	20 (33.9)	

3.5 | Hospitalization

There were 33 unscheduled hospitalizations (28.2%). There was no significant difference in the number of unscheduled hospitalizations between the two groups (32.1% of YPs and 24.6% of OPs, $P = .36$). However, the causes of unscheduled hospitalization varied. In the OP group, the principal cause of hospitalization was to manage an AE after it was reported via the telemonitoring application (vs 44% in YPs, $P = .02$). The disease progression was the most frequent cause in the YP group (vs 40% in OPs).

3.6 | PFS correlated with the tolerance status for OPs

We divided the patients into two subgroups, based on their tolerance to their treatment in the first month (as detailed above and in Section 2). Figure 2 shows the tolerance status for all patients throughout their treatment, with a focus during the first month for OP.

The median follow-up was 8.2 months. The PFS ratio at 6-months was 51.4% in the tolerant group vs 44.9% in the nontolerant group (HR = 0.4598, 95% CI = 0.4598-1.1362, $P = .0923$) (Figure 3A). In OPs, the PFS ratio at 6-months was 64.6% in the tolerant patients vs 23.4% in the nontolerant patients (HR = 0.1980, 95% CI = 0.04431-0.8845, $P = .0339$) (Figure 3B). The median PFS was 23.3 months in the tolerant group vs 3.3 months in the nontolerant group ($P = .0339$).

The data of overall survival are still immature.

4 | DISCUSSION

Our study is one of the first to investigate the compliance of older cancer patients with the use of a digital platform and the impact of the first-month tolerance to treatments on PFS in OPs. For our study,

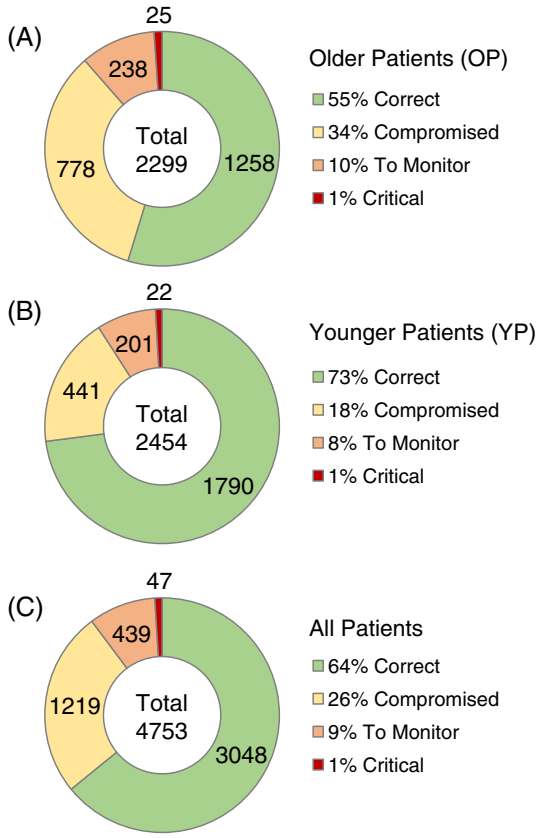

FIGURE 1 Number of patient-reported outcome questionnaires completed by: (A) older patients; (B) younger patients; (C) all patients [Color figure can be viewed at wileyonlinelibrary.com]

TABLE 2 Comparison between young and old patient

Variables	Age < 70	Age ≥ 70	*P* value
Compliance			
No	15 (28.8)	23 (38.3)	.29
Yes	37 (71.2)	37 (61.7)	
Tolerance			
No	14 (25.5)	13 (21.3)	.60
Yes	41 (74.5)	48 (78.7)	
Unscheduled hospitalization			
No	38 (67.9)	46 (75.4)	.36
Yes	18 (32.1)	15 (24.6)	
Causes of unscheduled hospitalization			
Disease progression	10 (55.6)	6 (40.0)	.02
Adverse events	8 (44.4)	9 (60)	

we defined the "first-month tolerance" of a patient based on the health classification computed by the telemonitoring tool Cureety from the patient's response to an AE questionnaire, as described in detail in Section 2.

The benefits of telemonitoring are well established, in particular a demonstrated improvement in the quality of life of cancer patients. Basch et al determined the effect of remote monitoring on 766 cancer patients, and showed that their quality of life was significantly improved (34% vs 18%, $P < .001$).[4]

Remote monitoring was also found to improve the overall survival of cancer patients. Denis et al assessed the impact of a remote monitoring platform on the overall survival of patients with bronchial cancer, compared to the standard practice.[5] The mortality risk was reduced by 68% in the patients monitored with the platform (hazard ratio = 0.32, 95% CI = 0.15-0.67, one-sided $P = .002$).[5] Remote monitoring also has medico-economic benefits. Russo et al reported a gain of 145 miles and 142 minutes per trip with an average savings of $18 555 per year.[6]

For OPs, such benefits have already been found in the case of chronic diseases such as diabetes and cardiovascular diseases. Antonicelli et al have shown a decrease in the number of deaths and hospitalizations in OPs with congestive heart failure that are monitored remotely.[7] Similarly, Martín-Lesende et al have shown that the use of remote monitoring leads to a reduction in the number of hospitalizations (total and cause-specific) in OPs suffering from heart failure or chronic lung disease.[8] In a metaanalysis, Wu et al evaluated the impact of mobile health apps for diabetes self-management, showing that 974 participants using such tools experienced a clinically significant reduction of HbA_{1c} (0.48%, 95% CI = 0.19%-0.78%).[9]

Monitoring from home allows a better follow-up and limits the use of emergency care for OPs, who are less mobile than YPs. It also has known medico-economic benefits[13,14] and it lowers geographic disparities in patient care, potentially giving access to the best level of care to all. Telemonitoring allows a regular follow-up of the patient with clinical or biological indicators. It helps the doctor implement actions as quickly as possible if needed.

Despite these known benefits, the implementation of telemonitoring is rarely part of the care pathway of OPs with cancer. The main barriers to adoption are the lack of internet access at home, digital illiteracy and the assumption that perioperative telemonitoring of OPs creates a high mental burden.[15]

Contrary to commonly-held beliefs, we have shown here that OPs are as compliant as younger patients when using the telemonitoring digital platform that was provided to them, with a compliance level above 60%. This tool allows the medical team to gain detailed knowledge of the tolerance profile of patients, and help monitor and maintain the quality of life of patients, which is a particularly important goal for older patients. These results show that telemonitoring should be included in the care pathway of all cancer patients, including OPs.

First-month tolerance to treatment was good in the OP group, with 79% of them classified as "tolerant" during the first month of telemonitoring. Only 28% of patients stopped their treatment and only five of them because of toxicity issues. This shows that the early advice delivered by the *Cureety* telemonitoring platform allows rapid management of AEs, thus ensuring the continuation of treatment and the expected benefits.

In addition, we observed a low rate of unscheduled hospitalizations in the older population, at less than 25%. Remote monitoring has a clear impact on unscheduled hospitalizations, as there were no

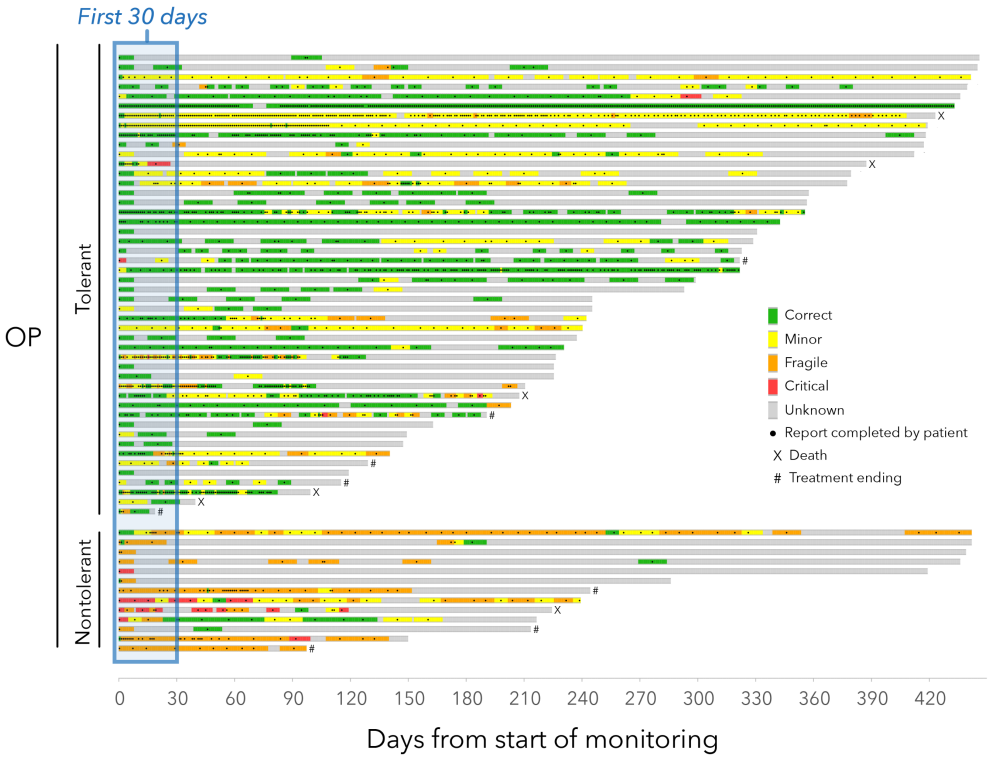

FIGURE 2 Timelines by status of tolerance for older patient (OP) [Color figure can be viewed at wileyonlinelibrary.com]

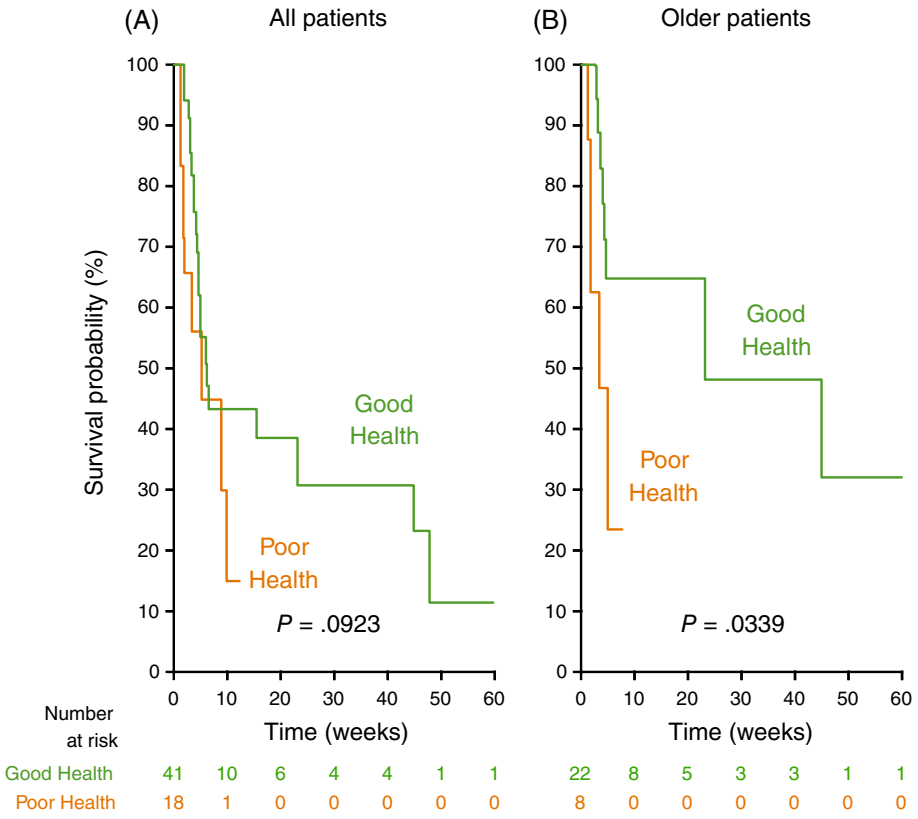

FIGURE 3 Progression free survival by tolerance status for (A) all patients; (B) older patient (OP) group [Color figure can be viewed at wileyonlinelibrary.com]

differences between the YP and OP groups. Pritchett et al also reported the positive impact of remote monitoring on unscheduled hospitalizations.[16] In fact, the use of remote monitoring was associated with a 78% relative risk reduction in hospital admission in their study.[16]

To our knowledge, this is the first study that assesses the use of PRO-based tolerance as a predictive factor of treatment response in OPs. We demonstrated here a significant 80% reduction in the risk of progression in OPs with good first-month tolerance. This suggests that ePRO follow-up might be an effective predictor of response and

a tool to treatment plan. These data are promising and need to be validated in a larger cohort.

5 | CONCLUSION

Overall, our work challenges the exclusion of OPs from telemonitoring solutions, who are wrongly assumed to be unable to use such tools. In our observations, OPs clearly benefited from using the telemonitoring platform that we have deployed in our hospital. Patients felt less isolated and felt that they benefited from personalized care. This solution makes it possible to streamline the OP care process.

AUTHOR CONTRIBUTIONS

All authors contributed in to the conception of the work; the acquisition, analysis, interpretation of data; and had approved the submitted version. The work reported in the paper has been performed by the authors, unless clearly specified in the text.

CONFLICT OF INTEREST

The authors declare no conflict of interest with this work.

DATA AVAILABILITY STATEMENT

The data that support the findings of our study are available from the corresponding author upon request.

ETHICS STATEMENT

Our article has been reviewed and approved by a local ethics committee. The study was declared to the French institute for health (*Institut National des Données de Santé*, *INDS*, *Data* MR) and was reported to the French organism for the protection of personal data and individual liberties (Commission Nationale de l'Informatique et des Libertés, CNIL; reference number: 2222625). All patient gave a written consent.

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