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Art and digital technologies to support resilience during the oncological journey: The Art4ART project

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ABSTRACT

Introduction: New digital technologies can become a tool for welcoming the patient through the artistic dimension. Cancer patients, in particular, need support that accompanies and supports them throughout their treatment.

Materials and methods: The Art4ART project consist in the structural proposal to cancer patients of a web-based digital platform containing several forms of art as video-entertainments; a multimedia immersive room; an art-based welcoming of the patients with several original paintings; an environment with a peacefulness vertical garden; a reconceptualization of the chemotherapy-infusion seats. Data regarding patients' preference and choices will be stored and analysed also using artificial intelligence (AI) algorithm to measure and predict impact indicators regarding clinical outcomes (survival and toxicity), psychological indicators. Moreover, the same digital platform will contribute to a better organization of the activities.

Discussion: Through the systematic acquisition of patient preferences and through integration with other clinical parameters, it will be possible to measure the clinical, psychological, organisational, and social impact of the newly implemented Art4ART project. The use of digital technology leads us to apply the reversal of viewpoint from *therapeutic acts* to *patient-centred care*.

Art and digital technology in radiation oncology

This paper aims to describe the objectives and methodology of a new, innovative project started at Gemelli ART, whose primary intent is to give a lead role to *art* in assisting patients through various oncological treatments. Art4ART is an acronym for "art for Advanced Radiation Therapy."

In the history of medicine, art has been recognized as an appropriate tool for alleviating suffering. It is documented by the structures called "*xenodochium*" (ancient hostels that, by accommodating pilgrims, acted as places of assistance for their welfare needs) and then converted into primordial hospitals, where treatments that were still rudimentary were practiced in rooms that are now rightly used as a museum [1]. Technological progress has meant that the place of treatment has to focus on

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the disease through diagnostic or therapeutic care services. Progressively, care models centered on the single therapeutic act have been oriented towards a patient-centered organization [2,3]. As recognized by the World Health Organization, digital health is now emerging in the medical environment for decision-making and helping patients' compliance, contributing to patient empowerment in person-centered care [4–6]. Digital technologies can be a helpful tool to improve cancer patients' treatment compliance and quality of life. Through the digitization of patient admission, it is possible to connect mHealth (mobile health) and eHealth (the use of information and communication technologies for health) applications in an interoperable way. For example, the mHealth and eHealth apps can assess patients while they take a virtual museum tour or interact with their family and friends.

Cancer is a burdensome disease with a chronic course, and its extensive consequences can lead to significant impairments in patients' physical and mental well-being [7]. Patients undergoing radiotherapy (RT) are prone to show distress, anxiety, and depression [8] because RT requires an everyday burden, often worsened by concomitant chemotherapy. The duration of treatments and the possible side effects are challenging for cancer patients [9]. These are long-term treatments performed mainly on an outpatient basis, often leading patients to remain away from home for a long time. So, patients face complex treatments and symptoms and suffer from cancer pain, experience the loss of independence, and lengthy, invasive medical procedures. Many patients perceive a decreased quality of life (QoL), pain, and emotional distress at the onset of cancer treatments[10]. Moreover, it must be considered that physical well-being decreases during the therapy, alongside increasing side effects [10]. The recommended strategy for alleviating distress is connecting patients with various coping processes through psychosocial support programs. Several studies have suggested that cancer patients can benefit from specific complementary therapy in conjunction with standard medical treatments such as chemotherapy and RT [11]. Among various complementary psychological therapies, art therapy effectively alleviates symptoms and improves the ability to cope with distress [12]. Art therapy is defined as a mind–body intervention supporting the 'power of the mind to influence the body in ways which encourage and stimulate health well-being [13]. Psychological benefits of art therapy have been suggested in empowering individuals to recalibrate their sense of self, the adjustment process, and perceptions of stress [14]. Art therapy can reduce negative symptoms regarding anxiety and depression and increase feelings of energy [14]. In the last decade, neural correlates of art perception, *aesthetic* experience to be precise, have been better defined. Cognitive neuroscientists have mainly used brain imaging techniques to investigate the neural underpinnings of preferences for paintings, human faces, and bodies [15].

The notion of the "aesthetic triad" was coined by Chatterjee and Vartanian [16] and meant that aesthetic experiences could be regarded as emergent states arising from a flexible interaction between three central neural systems: the sensory-motor, the emotion-valuation, and the meaning-knowledge systems. Aesthetic experiences are associated with activity within different subcortical limbic regions involved in reward computation and emotional processing, such as the insula, the amygdala, the ventral striatum, and the cingulate [15]. The artistic experience is shown as a "holistic experience": perceptive, emotional, and cognitive, that offers our brain benefits and advantage when it is carried out and subsequently in a person's life. The personalized approach to the cancer patient and his role as partner in treatment care is not a novelty at our Radiotherapy Department Gemelli ART (Advanced Radiation Therapy). The RAMSI project [6] effectively puts the patient at the center of the therapeutic process as a person in their complexity to preserve their QoL and human dignity during the radiation treatment. RAMSI project aimed to improve the services offered in a division of RT to improve the experience of care.

The building site of the digital revolutions for patients' well-being

The Art4ART project fits into the context of a structural and cultural revolution of the inpatient and outpatients that consistsin five proposals:

1) Web: A web-based digital platform (Fig. 1) has been developed to propose and share with the patient several forms of art as video entertainment by classifying each content according to eight human dimensions (friendship, love, attention, courage, self-care, enthusiasm, passion, and spirituality) and eight artistic channels (music, poetry, and literature, cinema, nature, painting, sculptures and monuments, photography, profession).
2) Orientation: An immersive multimedia room, where the patient, during treatments, can experience a 360° vision of video entertainment or several dedicated immersive experiences.
3) Aesthetic: An art-based welcoming of the patients with an architectural and semantic metamorphosis of the treatment places: the concept of a *waiting room* has evolved towards a *welcome room* for patients called 'Odeon' according to the ancient Greeks' idea of art-dedicated theatres, with an 8-meters HD television screen and a full-wall fresco painting (Fig. 2); an ordinal number no longer identifies the chemotherapy infusion seats, but they are characterized by the name of a flower (Fig. 3). Several original paintings are distributed along the common areas, including serigraphy reporting the flower that gives each chemotherapy infusion seat its name.
4) Green: Vertical gardens that introduce in a radiation oncology word the peacefulness of nature in complete continuity with the floral reconceptualization of the chemotherapy-infusion seats (Fig. 4). In addition, each patient will be given a seed which, if cultivated, will blossom at the end of the radio-chemotherapy treatment as a sign of hope.

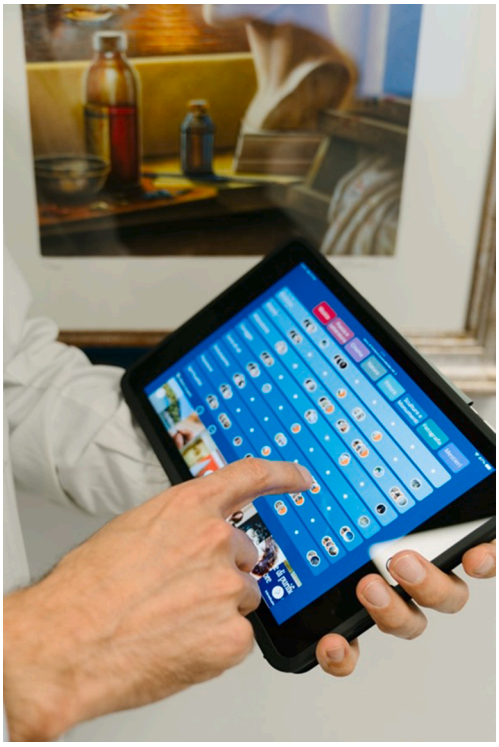

Fig. 1. In the web-based digital platform dashboard, each content has been classified according to eight human dimensions (friendship, love, attention, courage, self-care, enthusiasm, passion, and spirituality) and eight artistic channels (music, poetry, and literature, cinema, nature, painting, sculptures and monuments, photography, profession).

Fig. 2. The 'Odeon' welcome room, with the 8-meter HD television screen (in the center of the figure) and the full-wall fresco painting (on the right side of the figure).

Fig. 3. Two examples of the chemotherapy infusion seat (are the tulip and the sunflower).

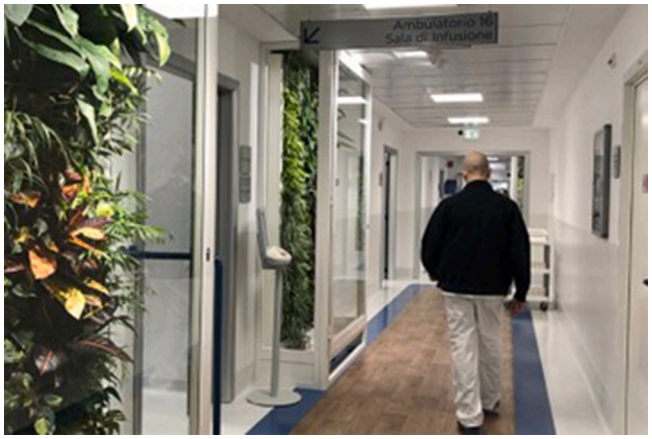

Fig. 4. The vertical gardens.

5) Intervention: The interventional oncology center (IOC), which offers interventional radiation therapy (brachytherapy) treatments to inpatients and outpatients, has, in addition, been equipped since December 2019 with MISSION (Mission MultISenSory Integrated System for patient cOmpliaNce improvement); such a system, according to the Humanity Assurance Protocol in interventional radiotheraPY (brachytherapy) indications [17], integrates the operating room and interventional radiotherapy delivery room with a home automation system with integrated app control of displays, multicolor LED lights, speakers and aroma/smell diffusers. The patient can select specific scenarios (e.g., mountain, sea) and be immersed in a personalized multisensory environment.

The artistic and digital proposal for the patient is not only a passive entertainment opportunity, but it also represents a tool that allows emotional profiling of the patient. Data regarding patients' preferences and choices will be stored and analyzed also using the artificial intelligence (AI) algorithm. The so obtained patient profiling can be integrated with other clinical data, leading to a holistic patient consideration with the perspective to customize treatments and supportive therapies further. In radiotherapy, the integration of AI and personalization is yet a reality to identify patients' responsivity, organ preservation, and QoL [18–19]. AI will have two main objectives: 1. To create a customized proposal in all the fields of arts available on the platform for each patient by profiling their preferences and tastes and monitoring psychological profile 2. To offer personalized tips for patients congruent with/her mood, disease phase, or treatment by providing patients with the beauty

of art as a complementary therapy and to increase patients'' resilience during their oncological journey. Art4ART project wants to link the narrative of the arts (cinema, music, painting, nature, literature, design) and the spiritual dimensions of a human being (friendship, love, passion, faith, etc.). The platform will allow the service of thematic entertainment to be easy to use at home during the therapeutic trajectories. The objective is to offer inner relief to individual needs with a supportive therapy integrated with scientific research. Moreover, possible comparative analyses of clinical outcomes of survival, toxicity, QoL, and compliance can be made between recruited patients and comparable patient cohorts treated before the introduction of the Art4ART project in order to establish the impact of the project on those outcomes. The resulting data will be retrospectively analyzed to identify in which clinical settings the impact of the platform in the care pathway seems to be most relevant. A further randomized trial will then be proposed to evaluate the effect of the digital platform in such clinical settings and to validate the previous evidence in a prospective cohort of patients.

In this artistic and cultural context, there are also meaningful opportunities for collaboration and participation in beauty through the volunteers of several civil and religious associations, which will help or participate in the patient' entertainment. In addition, volunteers will help patients who are unfamiliar with new technologies to take advantage of our digital offerings. While entertainment opportunities for patients are already in place, research on the clinical impact of this project is in the planning stage. Specifically, in our timeline, we expect to activate a prospective patient recruitment protocol (by the end of 2022 and early 2023) and to be able to perform an initial data analysis one year after the start of the recruitment phase by the end of 2024.

Pilot experience

International Scientific Societies have advocated for integrative therapies to manage cancer patients' symptoms. In addition, advances in digital technologies provide new opportunities to address limitations of standard treatments, such as medication non-adherence, adverse effects, and toxicity. Since the opening of the renewed department on 18/10/2021, a considerable number of patients availed of four of the Art4ART proposals accompanying the standard of care: Odeon's welcome room, vertical gardens, infusion seats, immersive space. In the last 6 months, 5387 chemotherapy sessions have been delivered, and 3227 day-hospital visits were performed (including setting visits, visits during therapy, and follow-up visits); concerning outpatient activities, in the same period, 1713 radiation therapy visits and 248 onco-geriatric evaluations were held; while 202 prehospitalization visits were performed for 473 admissions for the interventional and metabolic radiotherapy ward. Regarding the immersive room, we will offer up to 10 patients/week the vision of selected movies during chemotherapy infusion. We just started with a pilot proposal for cervical cancer patients undergoing chemotherapy with cisplatin[20]. Finally, since the implementation of the MISSION system, 5274 interventional radiotherapy fractions have been delivered in the years 2020–2021 in the multisensory delivery room.

Discussion and perspectives

Cancer patients configure an exciting but unexplored scenario concerning digital therapy. Cancer diagnosis develops a complex psychological microcosm in a person's life acting like an earthquake by its sudden irruption. Expectations and hopes alternately with fear and distress; vital patience is often required when patients deal with toxicities when waiting for the results of instrumental re-evaluations and during all the "waiting" to which they are subjected. Besides this, the clinical microcosm is characterized by therapies in continuous and rapid evolution, with new drugs, new technologies, and new procedures which may add uncertainties in patients.. Therefore, to help and complement the irreplaceable human face, digital technology can create an interface in which entertainment and sharing of content or information become a tool for responding to or reflecting on these needs. Advances in digital (i.e., information) technologies pace the rapid development of various methods and tools that can also be used in the healthcare system [21]. In the psychological area, digital technologies could support emotional health evaluation. In the sub-field of art therapy, growing evidence suggests that art therapists utilize digital media for personal and professional use and increasingly for treatment [22]. Therapeutic digital media provided to persons in need may include various creative 'apps' for art making such as video, animation, digital drawing, collage, photography, and augmented reality. In other care settings, a digital interface is a care pathway facilitator that can bring benefits both in terms of patients' attitude and involvement, thus improving participation in the care pathway and promoting better outcomes [7]. Digital health offers other advantages: it allows the small collection of patient data, makes subsequent visits more efficient and can allow an overall reduction of health and social costs, promoting the sustainability of the health system in our country.

In the Art4ART project, the use of digital technology leads us to apply the reversal of viewpoint from *therapeutic acts* to *patient-centered care*.

Individual applications already active at our digital health centre in clinical practice or clinical research are:

- the creation of large databases, allowing analysis of even extensive multicentric databases (data mining) or models from each center (distributed learning) [22–25];
- the study of administrative and clinical data to identify critical but hidden aspects of the process (process mining) [26–27];
- Quantitative analysis of radiological images with the proposal of new predictive models or clinical decision support systems [28–35], even using AI [36].

One sensitive issue is the management of personal data, collected via the Art4ART platform. The processing of personal data for studies based on the Art4ART project will be conducted by adapting its actions to the EU's 2016 General Data Protection Regulation (GDPR), the H2020 ethics standards, and the national law. The Art4ART platform will store information of patients who will give their explicit consent to participate in the project. Patient will be recruited in GENERATOR – RWD Tracer RT protocol, approved by the Ethical Committee of Fondazione Policlinico Universitario A. Gemelli IRCCS (ID: 3320). Data protection by design and default will be achieved by: the pseudonymization or anonymization of personal data; data minimization; applied cryptography (e.g. data encryption); using data-protection focused internal ICT service providers and storage platforms; and arrangements that enable data subjects to exercise their fundamental rights (e.g. as regards direct access to their personal data and consent to its use or transfer). Research data will be encrypted and devices on which they are stored, will be appropriately protected by password and security policy of the hospital ICT.

According to the interoperability of digital data storage and the administration, systematic acquisition and integration of new data is a stimulating and unexplored field. For example, it will be possible to supplement patients' feelings and attitudes with the currently available systems, including Internet of things devices (IoT), thus allowing continuous and real-time patient monitoring. The impact of integrating digital technologies and artistic inputs is expected in psychological, clinical, organizational, and territorial contexts. Psychological effects can be evaluated with instruments validated by scientific literature to assess: the patient's status in terms of distress and anxiety/depression [9–10]; the enjoyment of the proposed entertainment; the astonishment/artistic suggestion effect [37]; the patient experience [38], and to promote functional coping styles [39]. This impact will not only intervene on a single stage of the care pathway, but it will reverberate on the whole care process and all the people involved. Caregivers and healthcare professionals acting in patient care could benefit from this approach. Of considerable interest is also the impact that the

introduction of a digital interface may have on clinical outcomes, particularly in terms of patient tolerance and compliance during treatment, both in the short-term disease control and survival in a long time. In parallel, we will investigate whether the use of the digital platform is associated with a reduction of treatment toxicity and an improvement in compliance, thus promoting adequate coping strategies. The proposed tool should also offer improvements to the service organization. Specifically, the software can interact with the ward's diary management applications, collecting data such as the total number of visits/activities, the average time between a pre-call and the next, and satisfaction evaluation.

Conclusion

The Art4ART pilot project represents an unprecedented opportunity to reveal how the digital revolution can improve patient care. Beginning with patient entertainment, which is already available, the long-term goal is to scientifically demonstrate and quantify the benefits and impact on the resilience of cancer patients. The Fondazione Policlinico Universitario A. Gemelli is the clinical reference Hospital for the whole Center -South of Italy. For this reason, it will be interesting to evaluate the secondary effects that our project will bring on a territorial level. Digital health is one of the most exciting perspectives for clinical research. However, digital health requires specific training of healthcare staff [40] and complex management linked to patient safety and ethical and legal issues [41–42]. Integrating digital health, patient feelings, patient-centered resilience enhanced strategy, and art can become a prototype for digital humanism, where each technology is always thought to serve the patient with the best treatment and human proximity [43].

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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