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SPECIAL ISSUE

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Head and neck cancer radiotherapy amid COVID-19 pandemic: Report from Milan, Italy

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Abstract

Background: Management of head and neck cancers (HNC) in radiation oncology in the coronavirus disease 2019 (COVID-19) era is challenging. Aim of our work is to report organization strategies at a radiation therapy (RT) department in the first European area experiencing the COVID-19 pandemic.

Methods: We focused on (a) dedicated procedures for HNC, (b) RT scheduling, and (c) health care professionals' protection applied during the COVID-19 breakdown (from March 1, 2020 to April 30, 2020).

Results: Applied procedures are reported and discussed. Forty-three patients were treated. Image-guided, intensity modulated RT was performed in all cases. Median overall treatment time was 50 (interquartile range: 47-54.25) days. RT was interrupted/delayed in seven patients (16%) for suspected COVID-19 infection. Two health professionals managing HNC patients were proven as COVID-19 positive.

Conclusion: Adequate and well-timed organization allowed for the optimization of HNC patients balancing at the best of our possibilities patients' care and personnel's safety.

KEYWORDS

COVID-19, departmental procedures, head and neck cancer, health care protections, radiation oncology

1 | INTRODUCTION

Since the February 20, 2020, Italy is experiencing one of the most severe coronavirus disease 2019 (COVID-19) outbreak worldwide, with the region of Lombardy being the first area in Europe hit by the pandemic. At present, Lombardy is the most affected areas in Italy, with 15 116 deaths and 82 904 cases as of May 12, 2020. Of these, 21 632 were diagnosed in the Milan area. Therefore, health care services across the Region are still facing and unprecedented challenges in

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limiting transmission rates in order to guarantee the continuity of care.[1]

Patients with cancer are often frail and immunocompromised, and therefore at risk of being more severely affected by COVID-19 infection.[2,3] Following the Regional resolution XI-2906 approved on the eighth of March 2020, selected centers were designated as oncological hubs, meaning that they were called to host patients from hospitals in the frontline for COVID-19 emergency. Since our Institution was included among Lombardy oncological hubs, a set of procedures were implemented in order to guarantee a safe care and working environment.

Several reports and recommendations have been published on the management of head and neck cancer (HNC) from both an ethical and surgical perspective.[4-6] Moreover, a recent consensus by the American and European Societies of Radiation Oncology (ASTRO and ESTRO, respectively) was published to provide guidelines on optimal radiation therapy (RT) strategies during the pandemic.[7] Nevertheless, issues related to the management of HNC patients during RT have not been reported yet. Hence, aim of the current work is to report on technical aspects and the organization strategies applied in a radiation oncology facility operating in the first European area hit by the COVID-19 pandemic. As fourth of May represents the end of the lockdown phase in Italy, we wish to share our experience, and to provide some highlights on how everyday activities were reorganized to face an evolving epidemiological scenario, together with the short-term results of our efforts.

1.1 | Peculiarities of HNC clinical management

With a number of incident and prevalent cases in Lombardy of 1583 and 2687 in 2019, respectively, HNCs can be considered as relatively rare. Nevertheless, a recent national Italian survey among Radiation Oncology facilities has shown that the majority of COVID-19 positive oncological patients had a diagnosis of either lung or HNCs and had their domicile in Lombardy.[1]

For the radiation oncologist, HNC patients in the COVID-era[8] the following peculiarities should be considered: (a) HNC are non-deferrable treatments,[9,10] (b) increase in overall treatment time (OTT) negatively affects survival in curative-intent treatments,[5,6] (c) patients are generally elderly, heavy smokers as well as affected by several comorbidities,[11-13] (d) as curative-intent RT is administrated in 25-35 fractions, patients are required to perform multiple hospital accesses, which may increases their risk of contagion,[7] (e) the need of removing patient's surgical masks in different phases of RT favors environmental dissemination of droplets,[5] (f) the frequent presence of a tracheostomy represents a further mean of viral spreading,[14] (g) abundant mucous secretions with cough secondary to tumor- and treatment-related distress might further favor cross-infections, (h) high risk of developing ab-ingestis pneumonitis as a consequence of tumor and/or treatment-related swallowing impairment could make patients prone to pulmonary distress syndromes,[15] and (i) the combined effect of RT and concomitant systemic treatments (mainly platinum-based chemotherapy) could result in myelosuppression, thus favoring infectious disease.[16]

2 | MATERIALS AND METHODS

Data of HNC patients treated with RT at the Radiation Oncology Department of the European Institute of Oncology IRCSS (Milan, Italy) were reviewed. The considered time frame encompassed the early phase of COVID-19 pandemic in Lombardy (March 1, 2020 to April 30, 2020). The impact of the pandemic was analyzed as: (a) dedicated departmental procedures for HNC, (b) treatment scheduling (ie, delays, interruptions), and (c) health care professionals' protection was analyzed. As the current report focuses on outpatients treated with external beam RT, hospitalization and brachytherapy-related procedures are not described. Medical records from HNC patients were retrieved from electronic medical charts. This work was approved by the Ethical Committee of the European Institute of Oncology IRCSS (notification number IEO726). All patients signed a written informed consent for clinical research purposes.

3 | RESULTS

3.1 | Radiation Oncology Department—general organization

Eighteen radiation oncologists, 15 radiation oncology residents, 11 medical physicists, 25 radiation therapists, and six nurses are currently working at our department. On average, the number of outpatient treatments is approximately 900 per week. In this time of emergency, and given the role of oncological hub, our efforts were directed toward maintaining an efficient clinical routine.

For this reason, the entire workflow was reorganized to minimize COVID-19 transmission among both the personnel and the patients. All measures were coordinated by a COVID-19 emergency team composed by the chief of the department, three senior radiation oncologists, the

radiation therapist coordinator, the nursing coordinator, and the chief of the medical physics unit, in compliance with the institutional recommendations.

The health care personnel were assigned a COVID-19 exposure risk class. Personal protective equipment (PPE) was provided accordingly: (a) low-risk of COVID-19 exposure (surgical mask, disposable gloves), (b) intermediate risk of COVID-19 exposure (surgical masks, disposable gloves, disposable gowns, medical caps), and (c) high risk of COVID-19 exposure (filtering facepieces—FFP2/KN95 and FFP3 masks, disposable gloves, disposable gowns, medical caps, goggles or face shield, aprons). The administrative staff and the medical physicists were assigned to the first group, the health care professionals (namely, physicians, radiation therapists, and nurses) without contacts with HNC patients to the second group, and the health care professionals with contacts with HNC patients to the third group. All staff members were required to use PPE for the whole working day, regardless of whether their activity encompassed any direct contact with patients.

A full list of the policies for the whole department is provided in Supporting Information.

TABLE 1 Procedures developed at our department for patients with head and neck cancer

First outpatient evaluation	– As all patients were considered as potential COVID-19 asymptomatic carriers, medical doctors were equipped accordinglya – Clinical history on COVID-19-related symptoms was collected – Any strict contact with COVID-19-positive cases was recorded – Any swallowing and/or respiratory defect which could exacerbate cough and mucous secretion were minimized – Any swallowing and/or respiratory deficiency which could increase the risk of ab-ingestis pneumonia was considered – Medical beds and room equipment were cleaned with alcohol-based disinfectants after each consultation
Simulation CT	– All simulation CT were scheduled on a dedicated day – As all patients were considered as potential COVID-19 asymptomatic carriers, medical doctors and radiation therapists were equipped accordingly[a] – Thermoplastic masks and mouthpiece assisted bites were cleaned with alcohol-based disinfectants after each use – CT couches and set-up devices were cleaned with alcohol-based disinfectants following every treatment
RT treatment session	– All treatment sessions of HNC patients were scheduled in the morning – As all patients were considered as potential COVID-19 asymptomatic carriers, radiation therapists were equipped accordingly[a] – Treatment couches and set-up devices were cleaned with alcohol-based disinfectants after each treatment session – Thermoplastic masks and bite were sanitized with alcohol-based disinfectants after each treatment session
Clinical evaluation during RT	– Patients received a complete oral cavity and oropharyngeal examination at least once per week to assess acute RT-related toxicities – A dedicated consultation room was assigned to HNC patients, and sanitized at the end of each day – As all patients were considered as potential COVID-19 asymptomatic carriers, medical doctors and radiation therapists were equipped accordingly[a] – Medical beds and room equipment were cleaned with alcohol-based disinfectants after each consultation
Nursing care	– As all patients were considered as potential COVID-19 asymptomatic carriers, nurses and radiation therapists were equipped accordingly[a] – Skin medication requiring the removal of patients' surgical mask were performed only if strictly necessary – Patients were instructed to perform skin medication by themselves in order to minimize the risk of viral dissemination in the infirmary – In case of medication requiring the removal of the surgical mask, access to the infirmary was not allowed to any other patient – Medical beds and room equipment were cleaned with alcohol-based disinfectants after each procedure requiring the mask removal
Follow-up	– Telehealth surveillance was organized by phone to verify clinical status and results of prescribed radiological examinations

Abbreviations: CT, computed tomography; HNC, head and neck cancer; RT, radiotherapy.

[a]Personal protection equipment for health professionals managing HNC patients were: filtering facepieces-FFP2/KN95 and FFP3 masks, disposable gloves, disposable gowns, medical caps, goggles or a face shield, aprons.

3.2 | Departmental COVID-19 dedicated procedures

Treatment scheduling was not modified and was followed our institutional clinical practice: 6 weeks after surgery, 4 weeks after the last cycle of induction chemotherapy, within 4 weeks for exclusive radiation or concurrent chemoradiation.

The whole care path for HNC patients was re-planned according to temporal and special criteria, with the aim to maintain a safe working and treating environment. As previously detailed, patients were required to wear a surgical mask unless otherwise instructed by the personnel. A second surgical mask was provided to cover tracheotomies, if needed. A summary of dedicated procedures for HNC patients is provided in Table 1.

Time management in the COVID-19 pandemic encompassed scheduling all computed tomography simulation scans and RT delivery in dedicated slots. The rationale beyond these measures was to optimize room sanitization and to easily provide all involved health care professionals with PPE.

All treatments are performed with mouthpiece-assisted head and shoulder thermoplastics masks (FirmFit Thermoplastics Masks CIVCO Radiotherapy Corporate Office 2303, Iowa, United States of America), to minimize intrafraction and interfraction movements during treatment delivery. Due to our immobilization device of choice, it was not possible for patients to keep surgical masks during RT delivery. For safety reasons, patients were instructed to wear their surgical mask until they were correctly positioned on treatment couch. Subsequently, they were invited to remove the surgical mask and to insert their personalized mouth bites. The thermoplastic mask could therefore be applied by the radiation therapist, who performed the standard set-up procedures. The temporary removal of surgical masks by the radiation therapist managing HNC patients' set-up procedures were considered as a potential source of contamination, and an adequate PPE was provided accordingly (Figure 1).

Similarly, patients' surgical masks were removed at least once per week during medical consultations for oral cavity examination and toxicity assessment. A consultation room was reserved exclusively for HNC patients, and sanitized at the end of every working day. Clinical evaluations during the RT treatment were regularly performed. Follow-up consultations were organized according to the general department procedures detailed in Supporting Information. In detail, follow-up evaluations for HNC patients were organized in the form of telehealth surveillances, except for those requiring a physical and radiologic assessment of their gross tumor volume response following a curative-intent RT. In order to limit the

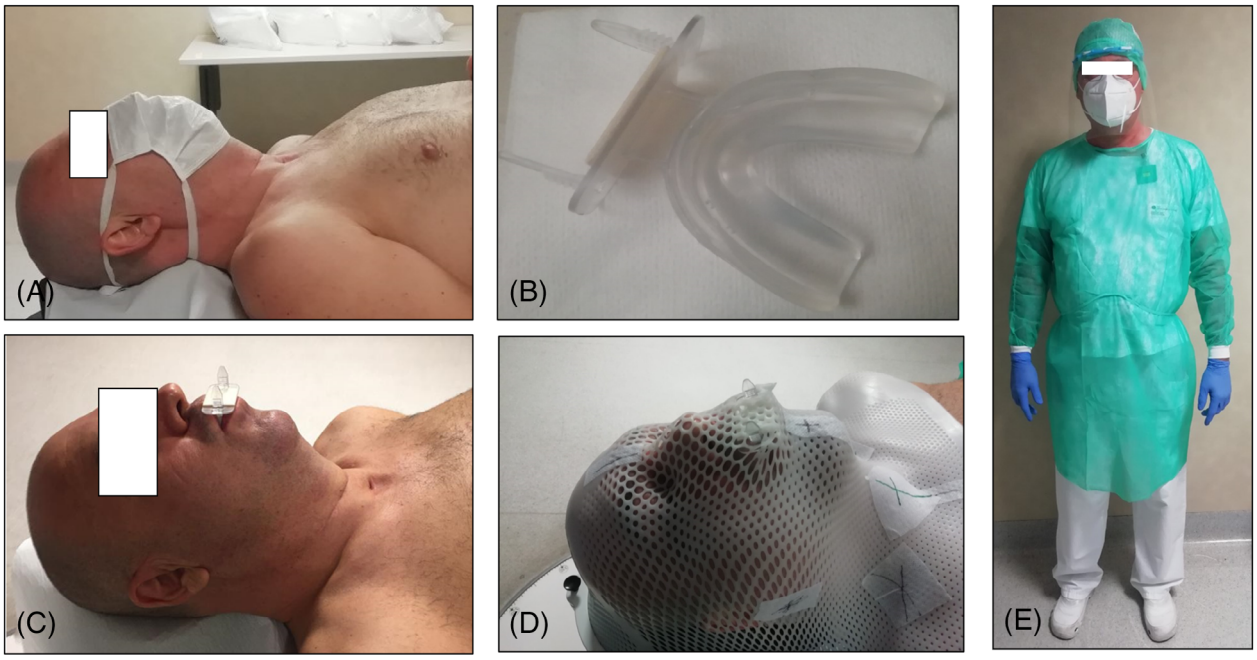

FIGURE 1 A, Surgical mask in place during the first phase of positioning on treatment couch. B, Detail of mouthpiece bite. C, Mouthpiece bite in place. D, Thermoplastic mask in place. E, Self-protection equipment for all health care professionals managing head and neck cancer patients [Color figure can be viewed at wileyonlinelibrary.com]

TABLE 2 Patients-related, tumor-related, and treatment-related characteristics

Total number of patients: 43	n (%)
Patients' characteristics	
Gender	
Male	30 (70)
Female	13 (30)
Median age (IQR), years	65 (57-74)
Patients' region of origin	
Lombardy	24 (55)
Other regions	19 (45)
Comorbidities	
Cardiovascular	17 (40)
COPD	10 (23)
Smoking status	
Active	12 (28)
Former	22 (51)
Never	9 (21)
Alcohol abuse	
Active	3 (7)
Former	1 (2)
Never	39 (91)
Tumor characteristics	
Disease subsite	
Oropharynx	13 (30)
Larynx	8 (19)
Oral cavity	5 (13)
Nasopharynx	5 (13)
Nasal cavity/paranasal sinuses	4 (9)
Salivary glands	2 (4)
Hypopharynx	2 (4)
Unknown primary	1 (2)
Other	3 (6)
Stage (per TNM 8th edition)	
I	3 (6)
II	5 (13)
III	11 (26)
IV	24 (55)
Treatment characteristics	
Radiation treatment setting	
Exclusive	25 (58)
Adjuvant	17 (40)
Palliative	1 (2)
Systemic therapy	
Yes	23 (54)
Induction + concomitant	4
Concomitant platinum-based CT	15
Anti-EGFR	4
No	20 (45)

Abbreviations: COPD, chronic obstructive pulmonary disease; CT, computed tomography; EGFR, anti-epidermal growth factor; IQR, interquartile range; TNM, tumor node metastasis (per American Joint Committee on Cancer).

accesses to our Institute, patients with no evidence of disease and good performance status were invited to stay at home and to reschedule their consultations.

All the above-mentioned procedures were progressively implemented according to pandemic development and in accordance with World Health Organization (WHO), National and recommendations and availability of Institutional resources.[17] While COVID-19 phase II started in Italy on May 4, 2020, these procedures are still applied in our department while this work is being written (10th of March).

3.3 | Impact of COVID-pandemic on HNC patients

Forty-three patients were included in the analysis. During the first 2 months of the COVID19 pandemic a slightly higher number of patients were treated at our department as compared with the same period of 2019 (44 vs 36, respectively, +22%). This could be probably explained by the fact that as a hub center, some patients were referred from other Institutions. All patients received image-guided intensity modulated volumetric arch therapy (VMAT). Two patients maintained their tracheostomy positioned at time of surgery. Patients' and treatment characteristics are provided in Table 2.

Postoperative RT was started after a median time of 58 (interquartile range [IQR] 53-69) days for the 17 patients treated with surgery. Exclusive RT was initiated after a median time of 29 (IQR 20-42) days following the first clinical examination performed by the radiation oncologist (22 patients). For the four patients who had undergone induction chemotherapy, a median time to RT start was 24 (IQR 14-30) days from the last cycle.

Median OTT was 50 (IQR: 47-54.25) days. Overall, RT was interrupted/delayed in seven patients (16%) as a consequence of a suspected COVID-19 infection. Specifically:

– One patient presenting with fever was diagnosed with COVID-19-related pneumonia on fourth of March after

receiving 18 Gy out of the prescription dose of 70 Gy for cT1cN2M0 HPV-positive oropharyngeal cancer, TNM eighth edition.[18] The patient required hospitalization for intensive respiratory distress of COVID-19 related pneumonitis and was treated at an intensive care unit of a dedicated COVID-19 hospital. After a quarantine period, the patient was proven negative at two consecutive nasal swabs (seventh of April). Due to a prolonged interruption of 57 days, after multidisciplinary discussion, a salvage surgery ± postoperative RT according to pathology specimen findings was proposed.

– Four patients had their RT interrupted following the onset fever. Nasal swabs tests were negative in all cases. RT breaks was 2 days for all patients.

– One patient interrupted curative RT for 23 days due to the quarantine measurements of her residence area. Treatment was interrupted at the dose of 62 Gy. OTT time was 105 days (further interruptions were needed for severe skin RT-induced toxicity).

– One patient with oral cavity cancer is experiencing a delay in the beginning of his adjuvant therapy. Following surgery, he subsequently developed COVID-19 pneumonia. Despite two consecutive swabs detected no sign of infection, the third one proved to be positive. Further two consecutive swabs performed recently demonstrated absence of COVID-19 infection. The patients are actually scheduled to start postoperative RT, which will be performed after 71 days from surgery.

Overall, follow-up consultations were regularly performed until April 19, 2020. Telehealth surveillance subsequently performed for 21 patients. Among these three patients who had completed their RT course, were scheduled for a short-term consultation for a more comprehensive assessment (tracheostomy removal, toxicity evaluation, and physical assessment of gross tumor response, respectively).

3.4 | Impact on health professionals

Overall, two health care professionals involved in the management of HNC patients (a radiation therapist and a radiation oncology resident, 51 and 33 years old, respectively) were found to be COVID-19 positive at nasal swabs. Both of them had been in contact with the patient diagnosed with COVID-19- related pneumonia. They have no comorbidities and clinical presentation of COVID-19 infection was mild in both cases (anosmia, diarrhea, fatigue, and fever). No respiratory symptoms were reported and hospitalization was therefore not needed. In compliance with safety measurements, both of them were re-admitted to work after two consecutive negative nasal swabs.

Since pregnancy, has been recognized as a risk factor for developing a COVID-19 related severe acute respiratory distress syndrome,[19] a radiation oncology resident in her seventh month of pregnancy was suspended from clinical practice and was assigned research works she could manage from home.

4 | DISCUSSION

Radiation treatment management of HNC patients in the COVID-19 era is challenging. As Lombardy was the first European area affected form COVID-19 pandemic, guidelines, and recommendation for RT in HNC patients were very limited at that time. Therefore, our department approved extra-caution measurements to maintain adequate safety standards for both patients and health care personnel to minimize the risk of transmission. Our experience has shown that the designation as an oncological hub, together with internal procedures, allowed preserving our standard of care while protecting health professionals treating HNC patients.

As COVID-19 likely binds to epithelial cells in the nasal cavities and the oropharynx,[20] aerosolized droplets from infected patients determine a high risk of transmission during the whole HNC clinical workflow, from diagnosis (ie, physical examination, trans-oral endoscopy) to treatment delivery (ie, surgery, RT ± systemic therapy).[5] During the emergency, it was difficult to identify a clear cut between our duty to provide optimal care and the one to protect health care professional and their families from infection.[5] Specifically, contamination reduction had to be balanced with the need of guaranteeing access to the best treatment options, as per national and international guidelines.[6] If an absolute solution to this ethical question is probably impossible to be found, the issue has been debated by some authors. Shuman et al advocate for a deliberate effort toward balancing exposure and maintaining moral and professional integrity in patient care.[21]

An additional concern for HNC patients who undergo RT is the counterbalance between the benefit of a timely delivered treatment and the risk of contracting COVID-19 infection during the 7 weeks of an average curative-intent irradiation. In this regard, Bhattacharjee et al developed a multistate and hazard model to simulate the risk of death from disease progression vs the risk of death from COVID-19 infection in patients diagnosed with stage IV cancer of the oral cavity.[22] Given the risks of hospital admission, the authors suggest to defer treatment in this subset of HNC patients and to make efforts

to minimize the chance of infection. While statistical models can provide reasonable solution to practical and ethical problems in the COVID-19 era, there was an unmet need for practice recommendations encompassing different clinical scenarios (ie, curative vs adjuvant treatments, high-risk vs low-risk adjuvant settings). To this aim, a joint effort by the ASTRO and ESTRO has produced an expert consensus statement for five common cases of HN carcinoma.[7] While the reader is invited to refer to the full recommendations, we would like to focus on the need of adequately prioritizing treatment at the time of limited resources. Of note, as the authors claim, all measurements and recommendations need to be weighted according to the extent and duration of the pandemic across nations and regions, which are hardly predictable and constantly evolving.[7] As hospitals represent critical areas in the epidemiology of the disease, it is therefore straightforward to understand how critical it is to keep transmission rates as low as possible in all health care facilities. The rationale of oncological hubs instituted in March 2020 is to provide the best treatment options to the highest number of safely eligible patients, in order to preserve oncological outcomes of these populations. Our experience shows that these measures were effective in limiting cross-infections for candidates to curative-intent RT for HNC. Overall, we did not experience a significant reduction in the number of treated patients, while maintaining high-quality standards for delivered treatments.

In the context of HNCs, IMRT has proven to be superior to three-dimensional conformal radiotherapy in reducing both acute and long-term treatment-related side effects (ie, xerostomia, dysphagia) without jeopardizing oncological outcomes.[23-25] Coherent with these results, we decided not to modify our planning strategies and to prioritize the maintenance of high-quality treatment standards for our patients. To this aim, set-up accuracy is an essential condition to ensure a safe and effective treatment delivery. Therefore, in order to assure an accurate set-up, our immobilization device is provided with a mouthpiece-assisted bite for every curative-intent treatment. A previous study from our department showed that using this device maintains the set-up error within 5 mm in all directions.[26] As we did not test the outcomes of patients' positioning without a mouthpiece-assisted bite, we favored to maintain our standard immobilization procedures despite they could not allow patients to wear surgical masks. Accordingly, all radiation therapists managing HNC patients were considered at high risk of COVID-19 infection and equipped with personnel protection accordingly. Therefore, they were instructed to safely use PPE, as well as to adequately sanitize treatment rooms and any equipment in contact with patients. Results of our report highlight that to maintain a high-quality standard of care, RT for HNC patients requires adequate personal protection as well as a department reorganization to optimize the room sanitization.

Considering that a percentage of individuals ranging from 13% to 30% were found to be COVID-19 asymptomatic, all HNC patients were considered as potentially COVID-19 carriers.[6,27] One of the limitations in our management was the impossibility to perform a swabs-based screening to all patients prior to the beginning of RT. A Chinese respective cohort study has underlined that the correct use of PPE prevented all 41 health care workers included in the analysis from being infected following the contact with COVID-19-positive patients.[28,29] Despite higher probability of contact with COVID-19 infected patients, Lombardy centers received, less PPE than the Italian average, most probably due to insufficient supply at the beginning of the outbreak. As an example, FFP2 and FFP3 provisions to the health care personnel were approximately 2 and 3 times lower in Lombardy than other regions, respectively.[1] Therefore, at our department during the first weeks of the outbreak, priority for PPE assignment was given to those managing HNC patients. Arguably, this strategy probably contributed to reduce cross-infections between potentially COVID-19 positive HNC patients and health care providers. The relatively limited number of COVID-19 cases among health professionals in our department could therefore be explained by contacts with asymptomatic carriers before rigorous self-protection measurements were introduced. Encouragingly, no other cases were diagnosed among our Colleagues recently. This might suggest that the high risk of cross-infection of HNC patient's management was mitigated by the use of adequate PPE.

We are well aware that further protective measurements could have been taken. Possibly, the risk of viral dissemination could have been further reduced by defining two separate working shifts for health care professionals, as well as by creating separate areas for patients at higher risk for COVID-19 infection. Serological screenings for the whole staff have been executed only in a minority of swab-proven cases, while a systematic testing is programmed for the upcoming weeks. However, at the time of the outbreak available guidelines and/or recommendation were scares and admittedly, the pandemic urged us to quickly address unprecedented issues and to balance patients' and personnel's safety and oncological indications.

Overall, the peculiarities of our experience derive from our designation as an oncological hub in an area of severe COVID-19 outbreak, from the patients' volume and from the need (especially in the early phases of the emergency) of optimizing the use PPE. However, our aim

is far from being either educational or didactic. The current work should in fact be considered as an early report of our management for HNC patients at the time of an unprecedented global health crisis. Nevertheless, we believe that it could be useful to provide our fellow radiation oncologists with a set of indication covering department organization in providing patients' and health professionals protection.

5 | CONCLUSION

We presented the first report analyzing the beginning of COVID-19 pandemic in Europe with a dedicated focus on HNC patient's candidate to curative radiation treatments. Results of the present work show that an adequate and well-timed organization (both in terms of national/regional and Institutional rules) permitted us to maintain a high-quality RT standard of care, balancing the best clinical practice with health care personnel's safety.

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CONFLICT OF INTEREST

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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REFERENCES

1. Jereczek-Fossa BA, Palazzi MF, Soatti CP, et al. COVID-19 outbreak and cancer radiotherapy disruption in Lombardy, Northern Italy. *Clin Oncol*. 2020;32:S0936655520301631. https://doi.org/10.1016/j.clon.2020.04.007.
2. Liang W, Guan W, Chen R, et al. Cancer patients in SARS-CoV-2 infection: a nationwide analysis in China. *Lancet Oncol*. 2020;21(3):335-337. https://doi.org/10.1016/S1470-2045(20)30096-6.
3. Achard V, Tsoutsou P, Zilli T. Radiotherapy in the time of the coronavirus pandemic: when less is better. *Int J Radiat Oncol*. 2020;107(3):S0360301620309317. https://doi.org/10.1016/j.ijrobp.2020.03.008.
4. Fakhry N, Schultz P, Morinière S, et al. French consensus on management of head and neck cancer surgery during COVID-19 pandemic. *Eur Ann Otorhinolaryngol Head Neck Dis*. 2020;137(3):159-160. https://doi.org/10.1016/j.anorl.2020.04.008.
5. Balakrishnan K, Schechtman S, Hogikyan ND, Teoh AYB, McGrath B, Brenner MJ. COVID-19 pandemic: what every otolaryngologist–head and neck surgeon needs to know for safe airway management. *Otolaryngol Neck Surg*. 2020;162(6). https://doi.org/10.1177/0194599820919751.
6. Kowalski LP, Sanabria A, Ridge JA, et al. COVID −19 pandemic: effects and evidence-based recommendations for otolaryngology and head and neck surgery practice. *Head Neck*. 2020;42(6):1259-1267. https://doi.org/10.1002/hed.26164.
7. Thomson DJ, Palma D, Guckenberger M, et al. Practice recommendations for risk-adapted head and neck cancer radiotherapy during the COVID-19 pandemic: an ASTRO-ESTRO consensus statement. *Int J Radiat Oncol*. 2020;20(S0360-3016):31034-31038. https://doi.org/10.1016/j.ijrobp.2020.04.016.
8. Yan F, Nguyen SA. Head and neck cancer: a high-risk population for COVID-19. *Head Neck*. 2020;42(6):1150-1152. https://doi.org/10.1002/hed.26209.
9. Graboyes EM, Kompelli AR, Neskey DM, et al. Association of treatment delays with survival for patients with head and neck cancer: a systematic review. *JAMA Otolaryngol Head Neck Surg*. 2019;145(2):166-177. https://doi.org/10.1001/jamaoto.2018.2716.
10. Levy DA, Li H, Sterba KR, et al. Development and validation of nomograms for predicting delayed postoperative radiotherapy initiation in head and neck squamous cell carcinoma. *JAMA Otolaryngol Head Neck Surg*. 2020;146:455. https://doi.org/10.1001/jamaoto.2020.0222.
11. Fazel A, Quabius ES, Fabian A, et al. The influence of smoking and co-morbidity on dose achievement in primary or adjuvant radio(chemo)therapy in head and neck squamous cell carcinoma (HNSCC). *Front Oncol*. 2020;10:398. https://doi.org/10.3389/fonc.2020.00398.
12. Stordeur S, Schillemans V, Savoye I, et al. Comorbidity in head and neck cancer: is it associated with therapeutic delay, post-treatment mortality and survival in a population-based study? *Oral Oncol*. 2020;102:104561. https://doi.org/10.1016/j.oraloncology.2019.104561.
13. Sharma A, Crosby DL. Special considerations for elderly patients with head and neck cancer during the COVID-19 pandemic. *Head Neck*. 2020;42(6):1147-1149. https://doi.org/10.1002/hed.26216.
14. Chow VLY, Chan JYW, Ho VWY, et al. Tracheostomy during COVID-19 pandemic—novel approach. *Head Neck*. 2020: https://doi.org/10.1002/hed.26234.
15. Mortensen HR, Jensen K, Grau C. Aspiration pneumonia in patients treated with radiotherapy for head and neck cancer. *Acta Oncol*. 2013;52(2):270-276. https://doi.org/10.3109/0284186X.2012.742205.
16. Winquist E, Agbassi C, Meyers BM, Yoo J, KKW C, the Head and Neck Disease Site Group. Systemic therapy in the curative treatment of head and neck squamous cell cancer: a systematic review. *J Otolaryngol Head Neck Surg*. 2017;46(1):29. https://doi.org/10.1186/s40463-017-0199-x.
17. World Health Organization (WHO). Rational Use of Personal Protective Equipment for Coronavirus Disease (COVID-19) and Considerations during Severe Shortages. https://www.who.int/publications-detail/rational-use-of-personal-protective-equipment-for-coronavirus-disease-(covid-19)-and-considerations-during-severe-shortages. Accessed May 13, 2020.

18. Huang SH, O'Sullivan B. Overview of the 8th edition TNM classification for head and neck cancer. *Curr Treat Options Oncol*. 2017;18(7):40. https://doi.org/10.1007/s11864-017-0484-y.
19. Qiao J. What are the risks of COVID-19 infection in pregnant women? *Lancet*. 2020;395(10226):760-762. https://doi.org/10.1016/S0140-6736(20)30365-2.
20. HCA Lung Biological Network, Sungnak W, Huang N, et al. SARS-CoV-2 entry factors are highly expressed in nasal epithelial cells together with innate immune genes. *Nat Med*. 2020;26:681-687. https://doi.org/10.1038/s41591-020-0868-6.
21. Shuman AG, Campbell BH, AHNS Ethics & Professionalism Service. Ethical framework for head and neck cancer care impacted by COVID-19. *Head Neck*. 2020;42(6):1214-1217. https://doi.org/10.1002/hed.26193.
22. Bhattacharjee A, Patil VM, Dikshit R, Prabhash K, Singh A, Chaturvedi P. Should we wait or not? The preferable option for patients with stage IV oral cancer in COVID-19 pandemic. *Head Neck*. 2020;42(6):1173-117 https://doi.org/10.1002/hed.26196.
23. Moon SH, Cho KH, Lee C-G, et al. IMRT vs. 2D-radiotherapy or 3D-conformal radiotherapy of nasopharyngeal carcinoma: survival outcome in a Korean multi-institutional retrospective study (KROG 11-06). *Strahlenther Onkol*. 2016;192(6):377-385. https://doi.org/10.1007/s00066-016-0959-y.
24. Kerr P, Myers CL, Butler J, Alessa M, Lambert P, Cooke AL. Prospective functional outcomes in sequential population based cohorts of stage III/ IV oropharyngeal carcinoma patients treated with 3D conformal vs. intensity modulated radiotherapy. *J Otolaryngol Head Neck Surg*. 2015;44(1):17. https://doi.org/10.1186/s40463-015-0068-4.
25. Gupta T, Agarwal J, Jain S, et al. Three-dimensional conformal radiotherapy (3D-CRT) versus intensity modulated radiation therapy (IMRT) in squamous cell carcinoma of the head and neck: a randomized controlled trial. *Radiother Oncol*. 2012;104(3):343-348. https://doi.org/10.1016/j.radonc.2012.07.001.
26. Ciardo D, Alterio D, Jereczek-Fossa BA, et al. Set-up errors in head and neck cancer patients treated with intensity modulated radiation therapy: quantitative comparison between three-dimensional cone-beam CT and two-dimensional kilovoltage images. *Phys Med*. 2015;31(8):1015-1021. https://doi.org/10.1016/j.ejmp.2015.08.004.
27. Li R, Pei S, Chen B, et al. Substantial undocumented infection facilitates the rapid dissemination of novel coronavirus (SARS-CoV-2). *Science*. 2020;368(6490):489-493. https://doi.org/10.1126/science.abb3221.
28. Ran L, Chen X, Wang Y, Wu W, Zhang L, Tan X. Risk factors of healthcare workers with Corona virus disease 2019: a retrospective cohort study in a designated hospital of Wuhan in China. *Clin Infect Dis*. 2020;17:ciaa287. https://doi.org/10.1093/cid/ciaa287.
29. Lai THT, Tang EWH, Chau SKY, Fung KSC, Li KKW. Stepping up infection control measures in ophthalmology during the novel coronavirus outbreak: an experience from Hong Kong. *Graefes Arch Clin Exp Ophthalmol*. 2020;258(5):1049-1055. https://doi.org/10.1007/s00417-020-04641-8.

SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of this article.

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