Rationale for Using a C-Arm Fluoroscope to Deliver a Kilovoltage Radiotherapy Treatment to COVID-19 Patients

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In 2013, Calabrese et al. described the effectiveness of early 20th century radiotherapy to treat viral and bacterial pneumonia patients, citing a cure rate of ~80%.[1] These were single fraction treatments of 30-100 cGy dose delivered with 100-200 kV_p x-rays. These treatments stopped in the 1940s due to the availability of antibiotics and steroids, but in light of the lack of effective treatment options for COVID-19, radiotherapy could offer a viable and immediate option[2,3] until a more effective cure becomes available.

A low dose radiotherapy to whole lung can be easily delivered with a linear accelerator (linac). However, transportation of an infected patient, who may be intubated, from the intensive care unit (ICU) to the radiation oncology clinic and back, could pose an imminent risk of viral spread and contamination. Cancer patients undergoing treatment, in addition to radiation oncology staff, could end up infected despite rigourous procedure protocols. Many cancer patients are immunocompromised, which amplifies the risk of sharing spaces with COVID-19 patients.

An alternative could be the use of fluoroscopy equipment to deliver a radiotherapy treatment similar to the historical treatments. X-ray energies comparable to those for which biological effectiveness was demonstrated in the past can be produced with modern fluoroscopes (e.g. fixed and mobile c-arms). C-arms are more widely available than linacs, especially in developing countries, and could be used to deliver a treatment in-situ and/or with minimal transportation to a procedure room.

Elderly patients (50 yo <) infected with the COVID-19 virus and at high risk of death, could be irradiated to low doses (30-50 cGy to the lung) using a c-arm system. The benefit-to-risk ratio of radiotherapy is particularly high for this patient population, who are less likely to develop secondary cancers due to reduced radiosensitivity. The treatment could be performed in the ICU or emergency room without the need to transport the patient to a radiation oncology clinic.

Although a more in-depth investigation would be needed, it can be speculated that delivery of a 30-50 cGy dose to the lungs could pose little risk of detriment and/or secondary cancers, especially in elderly patients.[4] Preliminary computer simulations (under peer review) have suggested that the doses delivered to other radiosensitive tissues exposed by this treatment could be within the range seen in cardiac interventional procedures, with skin doses around 200-300 cGy and cardiac doses around 50 cGy.[5]

Finally, the cost of treating COVID-19 patients with radiation could be cheaper and potentially more effective than with well-publicized experimental drugs. For instance, in the United States, it would cost over $3000 per treatment course for infected patients to be treated with remdesevir, even though the drug was shown to slightly reduce recovery time but not mortality.[6] A dedicated c-arm could treat multiple patients per day at minimal cost, which would improve treatment options for underinsured patients or those in low-income and developing countries.

References

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