Personalised/precision medicine: mRNA vaccines in cancer treatment

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Five years ago, the world was introduced to the newly developed mRNA vaccines to combat the SARS-CoV-2 virus. Most of us had not heard of this type of vaccine, yet it went on to save millions of lives worldwide, altering the course of the pandemic.[1] Researchers, using mathematical modelling, estimated the vaccine prevented 19.8 million (95% CrI 19.1–20.4) deaths in the first year (January 1, 2021, to January 1, 2022).[1] Since that time, it has become commonplace to receive boosters approximately every 6 months as the virus continues to mutate. Interestingly, however, what most of us didn't know was that scientists, even before the development of the COVID-19 vaccine, had been working on mRNA technology since 1995 to create individualized vaccines to treat several types of cancers.[2,3]

The overwhelming success of the COVID-19 mRNA vaccines, resulting in the awarding of the Nobel Prize for Physiology or Medicine in 2023 to Katalin Karikó and Drew Weissman, accelerated the application of this approach to oncology treatment by leveraging the body's immune system as part of immunotherapy. Similar to COVID vaccines, cancer vaccines are designed to deliver specific mRNA sequences by encoding cancer-associated antigens, prompting the immune system to recognize and mount a targeted response against malignant cells.[2,3]

The difference, however, between a vaccine for infectious diseases that targets well-defined antigens and those for cancer treatment is the interindividual heterogeneity of cancer antigens in patients. This complicates the development of these vaccines as they require a personalized or precision approach that involves obtaining a tumour sample from the individual patient.[2,3] Once the genetic sequencing of the tumour is identified, the mRNA vaccine can then be designed to target tumour-specific neoantigens, prompting a robust immune response.[3] When compared to traditional treatments, these vaccines have been reported to have better efficacy as well as specificity.[2,3] Other considerations in the development of these cancer vaccines are their design, delivery system, and mode of administration, which differ for the various types of cancers.[3] Recently, nanoparticles made from lipids or polymers have shown promise as effective delivery vehicles; many more are under investigation.[2]

So, with the exciting development of these new mRNA vaccines, I'm sure you are all wondering what kinds of cancers are being targeted by this technology. A search of the US National Library of Medicine's online database of clinical studies currently underway around the world (ClinicalTrials.gov) found 116 clinical trials for mRNA cancer vaccines. These trials include a wide range of cancers such as advanced malignant solid tumours; thyroid, esophageal, and pancreatic cancers; hematopoietic tumours such as leukemia, lymphoma, multiple myeloma; melanoma; colon, cervical, ovarian, prostate, and metastatic breast cancers; metastatic renal cell cancers; and glioblastoma. Most of these trials are in their early stages, but some have progressed to phase 2 and 3 clinical trials, and a few were listed as complete. This is a free site that is readily accessible to everyone, thus I recommend it as a good way to stay current with the progress of these vaccine studies.

Although a plethora of cancer types are currently under investigation, completed studies that have shown promising results in terms of safety, efficacy, and immunogenicity are those targeting melanoma and solid tumours.[2]

One exciting new study of a tumour-associated antigen (TAA) vaccine that has shown potent antitumour activity in mice was approved as an IDN (investigational new drug) by the US Food and Drug Administration on March 24, 2025.[5] This vaccine, EVM14, is an off-the-shelf, preservative-free, sterile mRNA-lipid nanoparticle cancer vaccine made with mRNA that encodes multiple TAAs for the potential treatment of various cancers, including non-small cell lung cancer (NSCLC) and head and neck cancer.[5] The IDN designation means this vaccine can now enter into a Phase 3 clinical trial, which is required before receiving final approval as a new drug therapy. The outcome of this Phase 3 global clinical trial will be of particular interest to all oral health professionals.

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These multiple new mRNA vaccine investigations for oncology treatment using this personalized approach, tailored to the individual patient, are indeed revolutionary! Although there are still some obstacles to work through, it appears that clinical trials are moving forward at groundbreaking speed globally, giving us all hope that the devastating effects of cancer—including oral cancers—will soon be a thing of the past. Jessica Foster, an oncologist at the Children's Hospital of Philadelphia, spoke of her colleague, Nobel Laureate Katalin Karikó:

> *"[Her] grit and determination to follow the science, despite many telling her she could not succeed, are an inspiration to all. She is a brilliant scientist, an incredible mentor, and a role model to female scientists across the world. The advances in mRNA biology she uncovered will change our lives for centuries to come."*
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> *—Jessica Foster, oncologist, Children's Hospital of Philadelphia*

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ISSUE AT A GLANCE

We are pleased to feature 4 original research articles and 3 literature reviews in this issue. **Marco Rizzo, Lorenzo Bevilacqua, Fabiano Barbiero, and colleagues** measure noise levels and acoustic discomfort experienced by dental hygiene students in a university dental clinic (pp. 161–70). **Alcir de Oliveira Júnior, Beatriz Loureiro Santos, and Fabio Mialhe** identify factors that lead adults to search the internet for oral health information (pp. 171–77). **Robin Gatlin, Justine Ponce, and Elizabeth Wagner** evaluate the extent to which rectangular collimation is taught in dental hygiene education programs and used by students in patient care (pp. 178-82). **Katherine Yerex, Dieter Schönwetter, and Caroline Monnon** seek to understand how face-to-face versus online teaching methods affect learning among dental hygiene and dentistry students with different learning styles (pp. 183–93). **Nazlee Sharmin and Ava Chow** review the use of large language models such as ChatGPT in dental and dental hygiene education and their impact on traditional assessment methods (pp. 194–205). **Lindsay Van Dam, Leigha Rock, and Sheri Price** review the research on interprofessional education for collaborative practice in oral health education (pp. 206-216). **Lina Al-Baghdadi** reports on the potential of teledentistry initiatives led by dental hygienists to improve access to care (pp. 217–23). Finally, a short communication by **Shubham Samantaray, Pallavi Patra, Sandeep Panda, and colleagues** describes the case of a benign oral lesion caused by smokeless tobacco use in a female patient (pp. 224-27).