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# Novel Vaccine Technologies in Veterinary Medicine: A Herald to Human Medicine Vaccines

## Explosion of Genetic Vaccines in Animals Gets Human Attention

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*The mRNA and adenoviral DNA COVID-19 vaccine debacle in humans has set populations on edge, distrustful of poorly conceived genetic technology. Meanwhile the field has advanced considerably in veterinary medicine. While these shots may protect animals from pathogens over the short term, what are the implications for our food supply? Any of the genetic material transmissible to humans through consumption? Raw or cooked? These and other questions are coming up as more information is being brought forward.*

Aida and colleagues have graphically summarized the genetic technologies in use as of 2021 in veterinary medicine. In the consumer meat category at present, only swine are of concern given the use of plasmid DNA, replication incompetent viral vector, and RNA replicon products. Do these technologies cause noninfectious diseases in the animals?

Can any of the genetic material survive denaturing during curing and cooking? How about pork intestines harvested for the production of heparin widely used in human medicine? It is conceivable that genetic incorporation of foreign RNA or DNA into humans and production of antigens for example, porcine endemic diarrhea or influenza A, could have untoward effects including autoimmunity similar to that with the COVID-19 vaccines?

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*Virginia Aida [1,2], Vasilis C. Pliasas [1,2], Peter J. Neasham [1,2], J. Fletcher North [1,2], Kirklin L. McWhorter [1,3], Sheniqua R. Glover [1,2] and Constantinos S. Kyriakis [1,2,4]**

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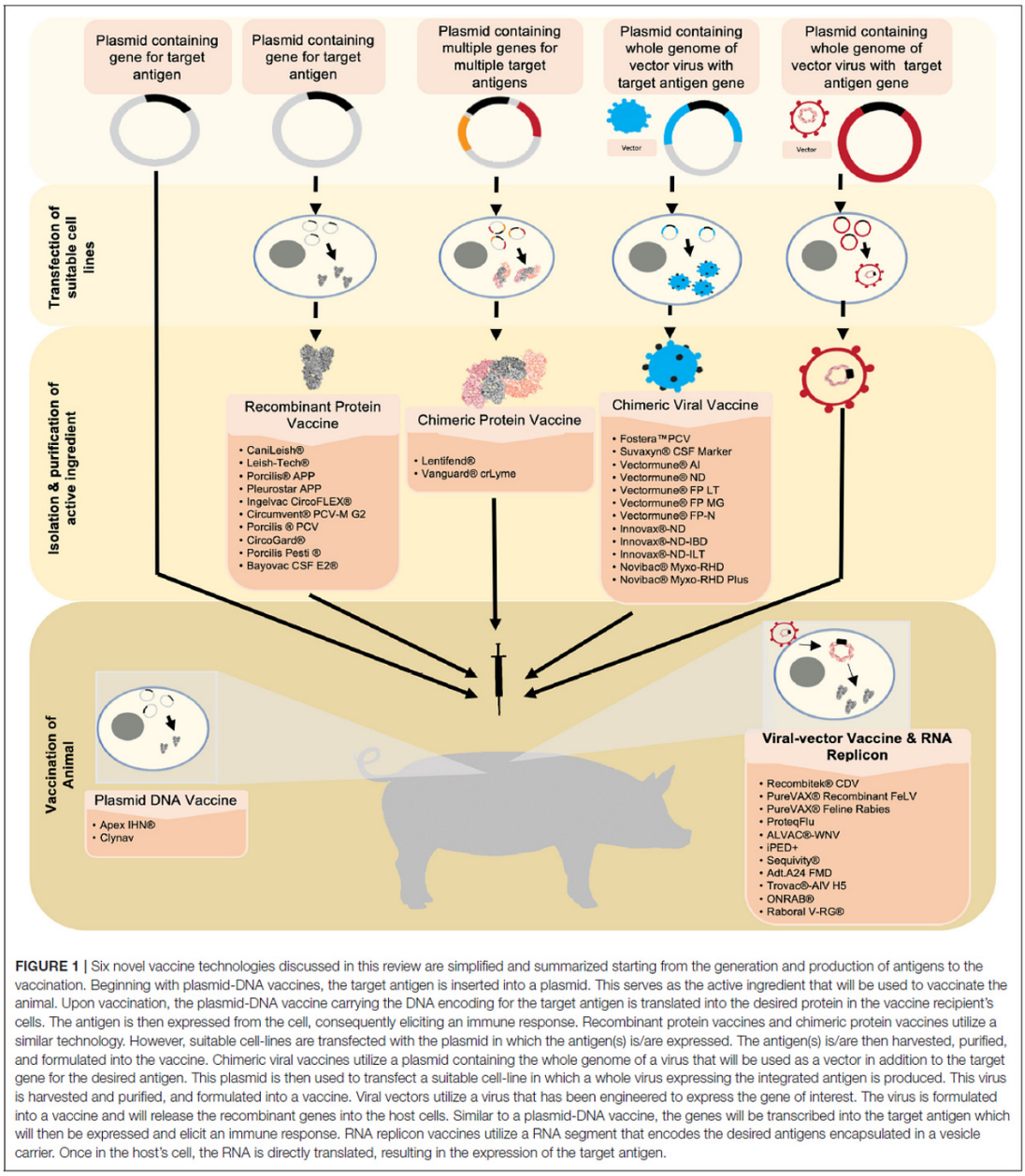


**FIGURE 1 |** Six novel vaccine technologies discussed in this review are simplified and summarized starting from the generation and production of antigens to the vaccination. Beginning with plasmid-DNA vaccines, the target antigen is inserted into a plasmid. This serves as the active ingredient that will be used to vaccinate the animal. Upon vaccination, the plasmid-DNA vaccine carrying the DNA encoding for the target antigen is translated into the desired protein in the vaccine recipient's cells. The antigen is then expressed from the cell, consequently eliciting an immune response. Recombinant protein vaccines and chimeric protein vaccines utilize a similar technology. However, suitable cell-lines are transfected with the plasmid in which the antigen(s) is/are expressed. The antigen(s) is/are then harvested, purified, and formulated into the vaccine. Chimeric viral vaccines utilize a plasmid containing the whole genome of a virus that will be used as a vector in addition to the target gene for the desired antigen. This plasmid is then used to transfect a suitable cell-line in which a whole virus expressing the integrated antigen is produced. This virus is harvested and purified, and formulated into a vaccine. Viral vectors utilize a virus that has been engineered to express the gene of interest. The virus is formulated into a vaccine and will release the recombinant genes into the host cells. Similar to a plasmid-DNA vaccine, the genes will be transcribed into the target antigen which will then be expressed and elicit an immune response. RNA replicon vaccines utilize a RNA segment that encodes the desired antigens encapsulated in a vesicle carrier. Once in the host's cell, the RNA is directly translated, resulting in the expression of the target antigen.

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**TABLE 2** | DNA vaccines.

| Species | Vaccines | Manufacturer | Pathogen | Plasmid(s) |
|---|---|---|---|---|
| Salmonid | Apex IHN ® | Elanco (Aqua Health) | Infectious Hematopoietic Necrosis | pUK21-A2, pUK-ihnG |
| | Clynav | Elanco (Aqua Health) | Salmonid Alphavirus Subtype 3 | PUK-SPDV-poly2#1 |

**TABLE 3** | Recombinant viral vector vaccines.

| Species | Vaccine | Manufacturer | Pathogen | Technology (viral-vector) |
|---|---|---|---|---|
| Canine | Recombitek® CDV | Boehringer Ingelheim | Canine Distemper Virus | Viral-Vector (canarypox) |
| Feline | PureVAX® Recombinant FeLV | Boehringer Ingelheim | Feline Leukemia Virus | Viral-Vector (canarypox) |
| | PureVAX® Feline Rabies | Boehringer Ingelheim | Rabies | Viral-Vector (canarypox) |
| Equine | ProteqFlu | Boehringer Ingelheim | Equine Influenza | Viral-Vector (canarypox) |
| | ALVAC®-WNV | Pfizer | West Nile Virus | Viral-Vector (canarypox) |
| Swine | Fostera™PCV | Zoetis | Porcine Circovirus Type 2 | Chimeric Viral-vector (PCV-1) |
| | Suvaxyn® CSF Marker | Zoetis | Classical Swine Fever virus | Chimeric Viral-vector (BVDV) |
| | iPED+ | Merck Animal Health | Porcine Endemic Diarrhea virus | RNA Replicon (VEEV) |
| | Sequivity® | Merck Animal Health | Swine influenza A virus | RNA Replicon (VEEV) |
| Bovine | Adt.A24 FMD | GenVec | Foot and Mouth Disease | Viral-vector (adenovirus) |
| Avian | Trovac®-AIV H5 | Boehringer Ingelheim | Avian Influenza | Viral-vector (fowlpox) |
| | Vectormune® AI | CEVA Biomune | Avian Influenza | Chimeric Viral-vector (HVT/MD) |
| | Vectormune® ND | CEVA Biomune | Newcastle Disease | Chimeric Viral-vector (HVT/MD) |
| | Vectormune® FP LT | CEVA Biomune | Infectious Laryngotracheitis virus | Chimeric Viral-vector (fowlpox) |
| | Vectormune® FP MG | CEVA Biomune | Mycoplasma Gallisepticum | Chimeric Viral-vector (fowlpox) |
| | Vectormune® FP-N | CEVA Biomune | Newcastle Disease | Chimeric Viral-vector (fowlpox) |
| | Innovax®-ND | Merck Animal Health | Newcastle Disease | Chimeric Viral-vector (HVT/MD) |
| | Innovax®-ND-IBD | Merck Animal Health | Newcastle disease and Infectious bursal disease | Chimeric Viral-vector (HVT/MD) |
| | Innovax®-ND-ILT | Merck Animal Health | Newcastle disease and infectious laryngotracheitis | Chimeric Viral-vector (HVT/MD) |
| Wildlife | ORNAB® | Artemis Technologies, Inc., | Rabies | Viral-vector (human adenovirus type 5) |
| | Raboral V-RG® | Boehringer Ingelheim | Rabies | Viral-vector (vaccinia virus) |
| Rabbits | Novibac® Myxo-RHD | Merck Animal Health | Rabbit Hemorrhagic Disease | Chimeric Viral-vector (myxoma virus) |
| | Novibac® Myxo-RHD Plus | Merck Animal Health | Rabbit Hemorrhagic Disease | Chimeric Viral-vector (myxoma virus) |

Now is a good time for veterinary and human medicine including the FDA and USDA, to come together and review the published studies of these new products on genetic transmissibility to humans and its potential implications. The Aida paper does not even mention the possibility of collateral impact to humans. One can see that developers, sponsors, and authors are blinded with infatuation for molecular biology and have lost sight of biological product safety in the food supply.

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Source

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