On the prevention of foot and mouth disease
by
Dr. HENRIQUE MARQUES LISBOA e Dr. ARMANDO ALVES DA ROCHA.

In a paper on the prevention of foot and mouth disease published in KOLLE and WASSERMANN's treatise, M. CASPER states that immunity follows an attack of this disease, but mentions that opinions on the duration of immunity vary.

We have had the opportunity to make observations in many foci of aphthous fever and have also been making an experimental study of this disease for over six years, so that we feel justified in giving our opinion on the subject.

The average duration of immunity after aphthous fever is about one year and we believe that the divergence of opinions on this point is due to the varying intensity of infection and to the degree of individual resistance. If an animal has a slight attack of foot and mouth disease it may be liable to another benign attack at the end of some six months, though this is very exceptional. The shortest period of immunity we observed lasted only four months and occurred after a very slight infection, following experimental inoculation of the disease. These cases were found among a herd of Devonshire cattle imported by the State of Minas Geraes. Four months after benign experimental inoculation with eighth bladed scarifiers, to test the vaccinating power of Cowpox, a pig with foot and mouth disease was put in the pen where this herd was kept. Other pigs in the same pen were contaminated and boils appeared on the skin of three head of cattle, accompanied by a slight rise of temperature. After two days the fever and the boils disappeared leaving no traces. If the animals had not been under observation, it is probable that the outbreak would not even have been noticed.

The longest period of immunity which came under our notice lasted for two years and occurred after a virulent attack.

We have never met with complete immunity though we have heard of it; but we were not given sufficiently convincing proofs of the positive risk of infection to which the supposedly immune herd was exposed. The fact that the disease be found in neighbouring ranches is not enough as one may only be sure of contagion when there has been promiscuity of healthy and sick cattle. It is well known that calves born of cows which had the disease in an advanced state of pregnancy, without miscarrying, are very refractory and
this is very striking when compared with the
sensibility of those born before an epidemic
of foot and mouth disease. Considering the
short time immunity lasts it is not to be ex-
pected that vaccination should confer resis-
tance for more than a few months. This is
however not so very important as an epide-
mic on a farm may last for only a month
or even less and seldom lasts longer. Immunity
for about a month or six weeks is quite suf-
cient as the epidemic may be crushed in
that time. *Loeffler* also mentions this fact

One of us had been experimenting so
as to find a practical way of inducing immu-
nity since 1912 and succeeded in finding a
process which we applied about two years
ago with quite satisfactory results. Before
describing the method itself, we would give
a synopsis of the several phases in the shaping
of it.

The very first obstacle we met with
was the difficulty of transporting the virus,
which was gathered about a mile and a half
from our laboratory at the Experiment Sta-
tion of Belo Horizonte. We inoculated the
gums of several calves but only one of them
had aphthae.

When the distance was longer we used
pure glycerine, or 30 % and 50 % glyceri-
ne solution as preserving medium for the
aphthae. Although we used ice and took
other precautions, no results were obtained
if the material took over twenty four hours
to reach us.

Sucking-pigs were then used for the
transportation of virus. We found that indi-
genous pigs were the worst possible carriers,
but obtained good results with some half
bred Yorkshires available near the Experi-
ment Station. *LOEFFLER* also obtained good
results with Yorkshires, though his may have
been pure bred.

The best way to infect them is to make
them swallow aphthae or other contami-
nated products, though it is advisable to
inject or to scarify the skin if it is neces-
sary to obtain pustules. Another good method
is to make the pigs suck cows that have
contracted the disease or to give them con-
taminated milk.

It is exceedingly difficult to keep the
virus in the laboratory unless sucking pigs
are available. We could hardly get calves
which were susceptible to the disease and
indigenous pigs gave very uncertain results.
On this account, we followed *LOEFFLER*’s
technique or got material from neighbouring
farms.

Pericardial liquid aseptically taken may
be kept for five days in 30 % glycerine and
often even for eight or ten. *LOEFFLER* men-
tions having kept it for thirty, but the long-
est we could manage was fifteen.

By inoculating Yorkshire pigs and with-
drawing their pericardial liquid, we immu-
nised a native cow which yielded a quite
active serum. Unfortunately we had to
abandon this method on account of the exor-
bitant price of half-bred sucking pigs and
the great mortality among them, especially
as these experiments were only made so as
to test our hypothesis. At the same time,
other experiments were carried out on Mr.
JOAQUIM NOGUEIRA’s farm in Queluz,
and gave very good results, thanks to the
good-will of this landlord and the thorough-
geness of our assistant JOAO CLAUDIO DE LIMA.

The work was done in the following
way: Aphthae taken from a bull that had had
a virulent attack of foot and mouth disease
were crushed in a mortar and diluted in
physiological solution; after that they were
filtered, first through large-meshed tissue and
afterwards through filtering paper. This took
about an hour. The substance thus obtained
was injected in the jugular vein of an ox that
had hitherto proved refractory to aphthous
fever. This was repeated four times, at in-
tervals of seven days and was done at night
so as to prevent the virus from being spoilt
by heat.

Ten days after the last injection,
we bled the ox at the jugular vein; the
serum obtained was kept in 0,5 % carbolic
solution. The epidemic died out on the
farm and as there was no communication between it and neighbouring farms it did not spread further.

The ox was then bought by the Experiment Station and its serum used on two lots of pigs bred near the slaughter-house. It proved to be preventive in doses of 40 cc. for adults and 20 cc. for suckling pigs. It was also used on two Large Black sows, in an advanced state of pregnancy, which suffered from the disease and had fever, varying from 41 to 42° C., with intense dyspnoea and were obliged to keep standing, with their heads low and their feet well apart. On the day following injection, the two sows showed no signs of the disease by which they might have been distinguished from the normal ones.

The serum had however no effect on pigs that already had aphthae and the disease ran its usual course.

A small quantity of the same serum was used with good results on some calves in Ubá, but as there were only a few of them we did not take them into account.

Other experiments in immunising animals were made near Juiz de Fora on a ranch belonging to Dr. HERMENGILDO VILLAÇA, to whom we are much indebted for his kindness. In this place the mortality among pure-bred Schweitz calves was terrible; five of them were dying when we arrived. We succeeded in immunising a cow from a neighbouring farm, on which the epidemic had spent itself. Ten days after the last injection, that is a month from starting of the work, the disease died out on the farm so that we had no further opportunities of testing the value of the serum obtained.

We then transferred the serum to JOÃO PINHEIRO, in the West of Minas Geraes and inoculated five calves which were taken from a farm where the infection was recent and severe. Another calf, taken from the same farm was used as witness; it fell ill after three days, had chills and a lot of aphthae in its mouth, whereas the calves that had been vaccinated did not contract the disease during the epidemic, which lasted four weeks.

Dr. HONORIO HERMETO also applied the serum in the same place with the same results.

On dosing the serum in our laboratory we found that 120 cc. protected adults, while 80 cc. were enough for calves over six months of age.

The efficacy of serum obtained by the injection of emulsion of aphthae during one month at least being proven we were prepared to make large quantities of it on the farms where epidemics occurred.

Just about this time several farmers appealed to the Minister of Agriculture so as to have the necessary measures taken against the disease. The work was entrusted by the then Minister, PEREIRA LIMA, to Dr. ALCIDES MIRANDA, the Chief of the Board of Pastoral Industry, who was given a government subvention for the carrying out of the same.

Our assistant Dr. FRANKLIN DE ALMEIDA made several liters of serum in the state of Rio de Janeiro, while we began to take prophylactic measures in the state of Minas Geraes; the serum was made in Ubá and used in Viçosa, Teixeiras and Ponte Nova.

The technique used was as follows:

1. Vaccination of well-developed head of cattle by rubbing aphthae on lips and tongue and sub-cutaneous inoculation of 100 c. c. of serum, 12 hours latter.

2. Intravenous injection of the emulsion of 2,5 gr. of aphthae, 6 days after the first injection.

3. Intravenous injection of the emulsion of 10 gr. of aphthae, 12 days after the first injection.

4. Intravenous injection of the emulsion of 10 gr. of aphthae, 18 days after the first injection.

5. Intravenous injection of the emulsion of 20 gr. of aphthae, 24 days after the first.

6. Letting of 4 liters of blood from the jugular vein, 10 days after the last injection.

7. After each bleeding, inducement of hyperimmunity by injection of 10 gr of fresh
aphthae, crushed in boiling water and filte-
red, first though cloth and afterwards through
filtering paper. The animals were always
bled 10 days after inoculation.

LOEFFLER warns against the use of
sputum and other contaminated products in
hyper immunising. As it is very difficult to
draw the liquid aseptically and filtering
through porcelain reduces virulence, we were
hardly ever able to work with virus from
natural infection. In a long series of injec-
tions LOEFFLER used for the most part peri-
cardial liquid and only seldom aseptically
taken aphthae, a fact which lengthened the pe-
riod for obtaining serum. When the aphthae
themselves are used, as was the case with
us, there is a great deal of spontaneous in-
fec tion which also lasts longer than that
obtained from intact boils. Besides this the
abundance of material allowed us to stren-
gthen the immunity in a relatively short
time. It is needless to exagge rate the danger
of contamination by this process as it is not
of much account; since cattle become immu-
nised against very virulent germs and much
more so against the ones generally found
in the mouth.

The value of the results obtained can be
deduced from the statistics we give. As we
were satisfied with these obtained in 1918,
we continued our work in 1919, with the
following results:

In 1916, at the request of Count MO-
DESTO LEAL, we set to work on his farm
in Morro Agudo, where there were cases of
foot and mouth disease. Thirty nine head of
cattle were inoculated by one of our assistants
and left with the sick cattle; they did not
contract the disease.

We then attended to the request of Co-
lonel ANNIBAL LOPES in Ipiabas, where
forty five head were inoculated and also
left with the sick cattle without having aph-
thous fever.

At the same time another member of
our party inoculated the cattle on a farm be-
longing to Captain LAUDELINO DA SILVA
in Pinheiro. Unfortunately there was not
enough serum to go round; of the eighty
nine head vaccinated, nine had the disease
some days after the injections were made.

In fact we attended to many requests
and obtained satisfactory results. The follow-
ing table shows the advantages of treatment
with anti-aphthous serum. In 80% of the
cases indemnity was obtained. If we exclude
the animals that fell sick 48 hours after vac-
cination, the general percentage rises almost
to 100%.

On a ranch in S. Vicente Ferrer, which
belongs to Mr. C. E. DE AZEVEDO, two
hundred and seventy head of cattle were
vaccinated; according to the owner they all
fell sick. The same thing happened in S.
Manoel amongst two herds. The serum had
been obtained by bleeding oxen that did
not resist immunisation and died several
days after being bled. This kind of accident
often happens to novices and hasty workers
who do not filter carefully enough. Under
these conditions septic particles get caught
in the capillaries of the lungs and form
centers of suppuration. When this occurs,
the cattle become thin and feverish, cough
a good deal and generally die on the twelfth
day after vaccination.
<table>
<thead>
<tr>
<th>Names</th>
<th>Locality</th>
<th>Animals Treated</th>
<th>Fell Sick</th>
<th>Percentage of Immunity</th>
<th>OBSERVATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Count Modesto Leal.</td>
<td>Morro Agudo</td>
<td>39</td>
<td>0</td>
<td>100/100</td>
<td>The infection was provoked.</td>
</tr>
<tr>
<td>2. Colonel Annibal Lopes.</td>
<td>Ipiabas</td>
<td>45</td>
<td>0</td>
<td>»</td>
<td>All the cattle were injected with serum and artificially infected.</td>
</tr>
<tr>
<td>3. Cap. Laudelina da Silva.</td>
<td>Pinheiro</td>
<td>89</td>
<td>8</td>
<td>91.1 %</td>
<td></td>
</tr>
<tr>
<td>4. Rodolpho Hess.</td>
<td>Passa Quatro</td>
<td>6</td>
<td>1</td>
<td>83.6 %</td>
<td></td>
</tr>
<tr>
<td>5. Lucas.</td>
<td>S. José do Picú</td>
<td>28</td>
<td>0</td>
<td>100/100</td>
<td></td>
</tr>
<tr>
<td>6. Viuva Mendes.</td>
<td>Itanhândú</td>
<td>6</td>
<td>0</td>
<td>»</td>
<td></td>
</tr>
<tr>
<td>7. Colonel Augusto Gomes.</td>
<td>Serra do Garrafão</td>
<td>44</td>
<td>3</td>
<td>93.6 %</td>
<td></td>
</tr>
<tr>
<td>8. Rambalducci.</td>
<td>Muquy</td>
<td>45</td>
<td>0</td>
<td>100/100</td>
<td>Of the 89 head, 3 were taken to a centre of the disease, the property of Dr. Aristides Caire, and were found to be immune.</td>
</tr>
<tr>
<td>9. Antonio de Freitas Lima.</td>
<td>Muquy</td>
<td>14</td>
<td>0</td>
<td>»</td>
<td></td>
</tr>
<tr>
<td>10. Colonel Francisco Fernando Flores.</td>
<td>Banco Verde</td>
<td>94</td>
<td>0</td>
<td>»</td>
<td>The two animals that fell sick before they were injected were considered suspect.</td>
</tr>
<tr>
<td>11. Light and Power. Cy</td>
<td>Lages</td>
<td>90</td>
<td>45</td>
<td>50.0 %</td>
<td>We had so much to do, we had no time for observation; we heard however that many head of cattle fell sick; perhaps of the serum not had been well prepared.</td>
</tr>
<tr>
<td>12. Dr. Ottini Raolino.</td>
<td>Ipiabas</td>
<td>140</td>
<td>0</td>
<td>100/100</td>
<td></td>
</tr>
<tr>
<td>13. Anthero de Moura.</td>
<td>Lages</td>
<td>16</td>
<td>0</td>
<td>»</td>
<td></td>
</tr>
<tr>
<td>14. Dr. Alberto Diniz Junqueira</td>
<td>Pinheiro</td>
<td>357</td>
<td>?</td>
<td>?</td>
<td></td>
</tr>
<tr>
<td>15. Posto Zootechnico de Pinheiro.</td>
<td>Pinheiro</td>
<td>350</td>
<td>0</td>
<td>100/100</td>
<td></td>
</tr>
<tr>
<td>16. Abilio Godoy.</td>
<td>Rezende</td>
<td>472</td>
<td>1</td>
<td>99.74 %</td>
<td></td>
</tr>
<tr>
<td>17. Baptista.</td>
<td>Rezende</td>
<td>18</td>
<td>0</td>
<td>100/100</td>
<td></td>
</tr>
<tr>
<td>18. Dr. Raul Ferreira Leite.</td>
<td>Realengo</td>
<td>89</td>
<td>0</td>
<td>»</td>
<td>The sick animal was injected as the owner wished it, though our assistant thought it suspect.</td>
</tr>
<tr>
<td>19. Josias Alves Nogueira.</td>
<td>Livramento</td>
<td>50</td>
<td>0</td>
<td>»</td>
<td></td>
</tr>
<tr>
<td>20. Dr. Luiz Cardoso.</td>
<td>Distrito Federal</td>
<td>50</td>
<td>2</td>
<td>96.0 %</td>
<td></td>
</tr>
<tr>
<td>21. José Eugenio de Azevedo Pinto</td>
<td>S. Vicente Ferrer</td>
<td>270</td>
<td>?</td>
<td>?</td>
<td></td>
</tr>
<tr>
<td>22. Guiot Rodrigues.</td>
<td>Rezende</td>
<td>180</td>
<td>7</td>
<td>96.8 %</td>
<td></td>
</tr>
<tr>
<td>23. Vicira Filho.</td>
<td>Pinheiro</td>
<td>81</td>
<td>1</td>
<td>98.8 %</td>
<td></td>
</tr>
<tr>
<td>24. Horacio da Costa Ferreira.</td>
<td>Rezende</td>
<td>123</td>
<td>0</td>
<td>100/100</td>
<td></td>
</tr>
<tr>
<td>25. Luiz Heurique Still.</td>
<td>«</td>
<td>51</td>
<td>0</td>
<td>»</td>
<td></td>
</tr>
<tr>
<td>26. Ezequiel Caetano da Silva.</td>
<td>Cabiunas</td>
<td>88</td>
<td>3</td>
<td>96.6 %</td>
<td></td>
</tr>
<tr>
<td>27. Leopoldina Maria Drumond.</td>
<td>«</td>
<td>62</td>
<td>2</td>
<td>96.8 %</td>
<td></td>
</tr>
<tr>
<td>28. Pedro Caetano da Silva.</td>
<td>«</td>
<td>26</td>
<td>0</td>
<td>100/100</td>
<td></td>
</tr>
<tr>
<td>29. Orestes Caetano da Silva.</td>
<td>«</td>
<td>32</td>
<td>2</td>
<td>93.8 %</td>
<td></td>
</tr>
<tr>
<td>Names</td>
<td>Locality</td>
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<td>Fell Sick</td>
<td>Percentage of Immunity</td>
<td>OBSERVATIONS</td>
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<tr>
<td>-------------------------------</td>
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<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>30. Diogo Pires de Amorim</td>
<td>Continho</td>
<td>110</td>
<td>0</td>
<td>100/100</td>
<td></td>
</tr>
<tr>
<td>31. Emiliano Bello de Amorim</td>
<td>Livramento</td>
<td>41</td>
<td>0</td>
<td>&lt;</td>
<td></td>
</tr>
<tr>
<td>32. Josias Alves Nogueira</td>
<td>«</td>
<td>98</td>
<td>0</td>
<td>&lt;</td>
<td></td>
</tr>
<tr>
<td>33. Cap. Francisco Pimentel</td>
<td>«</td>
<td>47</td>
<td>0</td>
<td>&lt;</td>
<td></td>
</tr>
<tr>
<td>34. Dr. Jayme Cotrim</td>
<td>Campo Bello</td>
<td>327</td>
<td>0</td>
<td>&lt;</td>
<td></td>
</tr>
<tr>
<td>35. Dr. Aristides Caire</td>
<td>Deodoro</td>
<td>22</td>
<td>22</td>
<td>0/0</td>
<td></td>
</tr>
<tr>
<td>36. Eurico Terra</td>
<td>Itaocara</td>
<td>113</td>
<td>3</td>
<td>97,3/00</td>
<td></td>
</tr>
<tr>
<td>37. Colonel Camillo Soares</td>
<td>Coelho Bastos (Município de S. Manoel)</td>
<td>60</td>
<td>0</td>
<td>100/100</td>
<td></td>
</tr>
<tr>
<td>38. Colonel Macario Garcia</td>
<td>Itaperuna</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>39. Julio de Aquino</td>
<td>S. Manoel</td>
<td>14</td>
<td>0</td>
<td>100/100</td>
<td></td>
</tr>
<tr>
<td>40. Cap. João Leandro</td>
<td>«</td>
<td>10</td>
<td>0</td>
<td>&lt;</td>
<td></td>
</tr>
<tr>
<td>41. Colonel Horacio Lemos</td>
<td>Benfica</td>
<td>147</td>
<td>0</td>
<td>&lt;</td>
<td>All the cattle, except 10 calves which we vaccinated had the disease.</td>
</tr>
<tr>
<td>42. Colonel Horacio Gomes</td>
<td>«</td>
<td>17</td>
<td>0</td>
<td>&lt;</td>
<td></td>
</tr>
<tr>
<td>43. Senator Francisco Salles</td>
<td>Capim Branco</td>
<td>109</td>
<td>0</td>
<td>&lt;</td>
<td></td>
</tr>
<tr>
<td>44.</td>
<td>Peripery</td>
<td>32</td>
<td>0</td>
<td>&lt;</td>
<td></td>
</tr>
<tr>
<td>45. Dr. Adolpho Soares</td>
<td>Ponte Nova</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>46. Geraldo Ubaldo da Silva</td>
<td>«</td>
<td>6</td>
<td>0</td>
<td>100/100</td>
<td>We found all the cattle in convalescent state.</td>
</tr>
<tr>
<td>47. Pellegrino Vianna</td>
<td>Alfenas</td>
<td>52</td>
<td>0</td>
<td>&lt;</td>
<td>Of these 146 pigs, 1 bull, 1 cow and 146 pigs were already ill.</td>
</tr>
<tr>
<td>48. Joaquim Jacintho</td>
<td>«</td>
<td>35</td>
<td>0</td>
<td>&lt;</td>
<td>These oxen were used for traction.</td>
</tr>
<tr>
<td>49. José Pinto Penna Carvalhal</td>
<td>Itanhandú</td>
<td>39</td>
<td>0</td>
<td>&lt;</td>
<td></td>
</tr>
<tr>
<td>50. Daniel Rocha</td>
<td>Tombos de Carangola</td>
<td>60</td>
<td>0</td>
<td>&lt;</td>
<td></td>
</tr>
<tr>
<td>51. Snr. Prates</td>
<td>Passagem de Marianna</td>
<td>15</td>
<td>0</td>
<td>&lt;</td>
<td></td>
</tr>
<tr>
<td>52. Francisco Jorge Diniz</td>
<td>Brumadinho (Cachoeira factory)</td>
<td>126</td>
<td>0</td>
<td>&lt;</td>
<td></td>
</tr>
<tr>
<td>53. Octavio Contigio Machado</td>
<td>«</td>
<td>9</td>
<td>0</td>
<td>&lt;</td>
<td></td>
</tr>
<tr>
<td>54. Colonel Firmino Mariano</td>
<td>«</td>
<td>148</td>
<td>0</td>
<td>&lt;</td>
<td></td>
</tr>
<tr>
<td>55. Antonio Amaral</td>
<td>Capella Nova</td>
<td>14</td>
<td>0</td>
<td>&lt;</td>
<td></td>
</tr>
<tr>
<td>56. Joaquim Jacintho</td>
<td>Alfenas</td>
<td>12</td>
<td>0</td>
<td>&lt;</td>
<td></td>
</tr>
<tr>
<td>57. Major Feliciano Pinto Brandão</td>
<td>«</td>
<td>86</td>
<td>0</td>
<td>&lt;</td>
<td></td>
</tr>
<tr>
<td>58. Dr. Adolpho Soares</td>
<td>Benfica</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>59. Francisco Jorge Diniz</td>
<td>Ponte Nova</td>
<td>28</td>
<td>0</td>
<td>&lt;</td>
<td></td>
</tr>
<tr>
<td>60. Board of Pastory Industria</td>
<td>«</td>
<td>23</td>
<td>0</td>
<td>&lt;</td>
<td></td>
</tr>
<tr>
<td>61. Dr. H. Vilaça</td>
<td>Rio de Janeiro</td>
<td>108</td>
<td>0</td>
<td>&lt;</td>
<td></td>
</tr>
<tr>
<td>62. Dr. José Rezende</td>
<td>Ubá</td>
<td>103</td>
<td>0</td>
<td>&lt;</td>
<td></td>
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