for colour-blindness and its photophobia, improving the vision and reducing the nyctagmus.

The contact glass is also valuable for serpentine ulcerations of the cornea, progressive abscesses, and other forms of keratitis, especially if the concavity of the glass is smeared with a disinfectant ointment. Other conditions for which it is useful include neuro-paralytic keratitis, some forms of sclerotic keratitis, acne rosacea of the conjunctiva and cornea, spring accarh, trachoma, pemphigus, xeroderma pigmentosa, hay-fever, kerato-iritis, dystrophia marginalis, and lagophthalmos. Contact glasses can also be used in cases of strabismus, at the end of the lids sweep over it.

Contact glasses are indicated for the treatment of squint, and one eye can be corrected by itself if desired. There are also occupational indications for this form of correction; architects, seamen, pilots, chemists, actors, and engineers should try it; so also should sportsmen such as skiers, bicyclists, swimmers, motorists, gymnasts, sailors, tennis players, and those who hunt.

Finally, there is the cosmetic indication; women who have pale grey or blue eyes can have them darkened to any desired degree by contact glasses.

Illustrative Cases.

CASE 1.—A man, aged 42, had lightning cataract with vision in the right eye of 6/6 with a +1 lens and in the left eye of 6/9 with a +10 lens. With a coloured contact glass 2/6 he obtained 6/6.

CASE 2.—A woman, aged 50, had 6/60 vision in both eyes, without glasses. With contact glasses 3/60 she obtained 6/60 vision, which she also obtains with contact glasses of 0.

CASE 3.—A girl, aged 8, had 6/18 vision in both eyes with spectacles (cylinder - 1, sphere - 6) and wore contact glasses 6/18 with a contact glass of 2/6. She also obtained 6/6 vision. She has worn her glasses daily since October, 1929, taking them out at night, and could not now do without them.

CASE 4.—A seaman, aged 35, a concert singer, suffers from myopia and astigmatism. She obtains 6/8 vision with a contact glass of 2/6 in the right eye and 3/80 in the left eye. When he first wore a contact glass of 76 he felt very uncomfortable, and his eyelashes seemed to scratch the cornea. In time, however, the cornea grew clearer and in a few months he had a vision of 1/10 and was able to wear the glasses continuously for a fortnight.

CASE 5.—A gamekeeper, aged 29, had a vision of 6/60 in the right eye and 3/60 in the left eye. With contact glasses 2/6 in the right eye and 3/60 in the left eye he has 6/6 vision, and he wears the glasses daily without discomfort.

CASE 6.—An orchestral conductor, 56 years old, is fit for sea again. With spectacles he has normal vision and is fit for sea again.

CASE 7.—A girl, aged 16, has 6/6 vision, which she also obtains with contact glasses of 0. At first she wore the glasses for an hour only, but after some days she became accustomed to them.

CASE 8.—A spinster, aged 20, has myopia with a little astigmatism. With spectacles (cylinder - 1, sphere - 6) she has 6/6 vision, which she also obtains with contact glasses of 0. At first she wore the glasses for an hour only, but after some days she became accustomed to them.

CASE 9.—A man of 30 has a normal right eye but the left has trachoma, pannus, and myopia, produced by keratoconus in the middle of the cornea. He can distinguish fingers at a distance of 9 ft. When he first wore a contact glass of 76 he felt very uncomfortable, and his eyelashes seemed to scratch the cornea. In time, however, the cornea grew clearer and in a few months he had a vision of 1/10 and was able to wear the glasses continuously for a fortnight.

It will, I think, be seen that contact glasses are likely to prove increasingly useful in ophthalmic work.

ANTIGENIC PROPERTIES OF DIPHTHERIA TOXOID-ANTITOXIN FLOCCULES.

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During the past few years several new forms of diphtheria prophylactic have been introduced. The object of workers in this field is to produce one which is safe, efficient, rapid in action, and free from non-specific poisonous materials, which—as is well known from the experience gained with the older forms of prophylactic—are apt to cause unpleasant local reactions, especially in adults. While many of the properties of diphtheria prophylactic can be studied and compared in laboratory animals, certain others, such as the liability to cause reactions on injection, can only be investigated in human beings, and the important question of the activity of prophylactics in producing rapid immunity must also eventually be investigated in human beings.

Through the courtesy of Dr. R. A. O'Brien, Director of the Wellcome Physiological Research Laboratories, I have had the opportunity, during the past two years, of studying the form of prophylactic known as "toxoid-antitoxin floccules" (T.A.F.) in a series of 87 nurses at the North-Western Fever Hospital. Attention has been specially directed toward the production of immunity as shown by the Schick reaction, the rate of production of the Schick-negative state and the degree of local and general reactions produced by the injections.

From the nature of their preparation, the floccules used would be expected to cause less reaction than the older forms of prophylactic. The preparation used in this work consists of a suspension in saline of the washed precipitate produced from mixtures of diphtheria toxoid and diphtheria antitoxin.

The first recorded observations on the antigenic activity of the precipitate produced by the interaction of diphtheria toxin and antitoxin were made by Park and his colleagues in 1924. They showed that "T.A.F."—"the product of precipitate from mixing toxin and antitoxin"—immunized guinea-pigs. Sordelli and Serpa in 1925 centrifuged the precipitate produced in an over-neutralised mixture of toxin and antitoxin and found that the precipitate and supernatant fluid had apparently equal immunising value. Hartley investigated the antigenic properties of the precipitate produced in under-neutralised, neutral, and under-neutralised mixtures of toxin and antitoxin and showed that the immunising value
of the first was low, that the precipitate from neutral
mixtures was non-toxic but of high immunising value,
while the precipitate from under-neutralised mixtures,
though toxic in relatively large doses, was a remark-
able active antigen. Hartley showed that these
washed precipitates contained less than 1 per cent. of
the total nitrogen present in the mixtures from which
they separate, and suggested that, working on these
lines, a relatively pure antigen—free, at least, from
the non-specific material frequently the cause of
local reactions—would be possible. The findings of
Harley were confirmed by Glenney, Pope, Waddington,
and Wallace, 4 and Glenney and Pope 5 showed that
the precipitates from mixtures of toxoid and antitoxin
are as good antigens as those prepared from
toxin and antitoxin.

The substitution of toxoid for toxin permits the
preparation of floccules entirely devoid of all risk,
and this form of diptheria prophylactic— toxoid-
antitoxin floccules—has been used in the present
work. O'Brien 6 states that the preparation seems
to be free from liability to cause local reactions in
human beings and quotes a series of 56 subjects
immunised by Okell and Parish, 45 of whom became
Schick-negative when tested from one to five months
later, after one, two, or three doses of toxoid-anti-
toxin floccules. Eberhard 7 states that the toxin-antitoxin floccule preparation introduced by Glenney
and Pope in 1927 is a better immuniser than ordinary
toxoid, and records that the painful local and constitu-
tional reactions, observed by no means infrequently
when the older forms of antigen are used, entirely
disappear when these floccules are used as immunising
doses.

In Germany, toxin-antitoxin floccules prepared by
Schmidt have been used to a considerable extent in
recent years. Schmidt and Scholz 8 in 1925 reported
that toxoid-antitoxin floccules immunised rabbits,
and from these results, and those obtained on man,
expressed the view that toxin-antitoxin floccules
constitute the best antigen yet available for the active
immunisation of man. They state that the injection
is painless, that the local reaction produced is trifling
but the majority (42) received three doses of 1 c.c.m.
each at intervals of a fortnight; eight received three
doses at weekly intervals; four had two doses at
fortnightly intervals, while one who was only weakly
positive received one dose only and a fortnight
later was found to be Schick-negative. Of those
who were still Schick-positive eight weeks or more
after the commencement of immunisation and received
more than three doses, the intervals between doses
varying from one to three weeks. Of these four, two
had six doses, one five, and one four. Whenever
possible a re-test was performed four weeks after the
last inoculation—i.e., from six to eight weeks after
the commencement of immunisation. Those proving
still positive were re-tested at intervals of four weeks
until they became Schick-negative.

Fortunately, no causes such as absence on leave, transfer to other institutions, illness or leaving the service, it was impossible to carry out
this programme in all the 87 positive reactors. Thus
19 were not re-tested after their course of immunisa-
tion. Of the remaining 68, 64 eventually became
negative and four left hospital while still positive.
In one of these immunisation was abandoned after the
first inoculation owing to a severe reaction. Another,
who was still positive ten weeks after the
last of three inoculations, refused a second re-test.
Of the remaining two, one, who was positive four
weeks after the last of three fortnightly doses, received
a further three doses and was still positive when she
left hospital 29 weeks after the commencement of
immunisation. The other was positive six weeks
later, when she, also, left hospital.

All four were first given a course of three inoculations;
subsequent re-tests being positive, one was given one more
dose and became negative 14 weeks from the commencement
of immunisation; another had two extra doses and became
negative in 22 weeks. Two received a further course of three injections, becoming negative in 16 and 29
weeks respectively. Comparing these results with those
obtained in Table I, it does not appear that in general agreement regarding the absence of local reaction following injection, advocate the use of more than one dose of prophylactic.

Method and Results of Investigation.
As a preliminary to commencing the use of toxoid-
antitoxin floccules in ordinary immunising doses a
small series of cases were first given one subcutaneous
injection of 0-25 c.c.m. Since the members of this
small group remained entirely free from troublesome
reaction, ordinary doses of 1 c.c.m. were thereafter
employed. All new nurses, numbering 211, were
Schick-tested within a few days of taking up duty
in the hospital. Reactions were read seven days
day later, when 87 proved to be positive and were at
once given a single dose of toxoid prophylactic. The
number of doses given and the intervals between consecutive
inoculations varied at different periods of the work,
but the majority (42) received three doses of 1 c.c.m.
each at intervals of a fortnight; eight received three
doses at weekly intervals; four had two doses at
fortnightly intervals, while one who was only weakly
positive received one dose only and a fortnight
later was found to be Schick-negative. Of those
The comparatively poor results shown in the series who had three doses at weekly intervals may be attributable to the fact that this series contained several long cases who were not re-tested early enough.

Precise details of the length of time elapsing between courses of immunisation and the proved establishment of immunity are scanty in the literature. Kelleher, in his report of immunisation work in a series of 224 boys on the training ship Exmouth, found that the average time dating from the first immunising dose was 2-9 months. The antigen used by Kelleher was the older T.A.M., but the average age of his cases was probably five or six years below that of the hospital nurses.

**Table I.** (55 Cases).

<table>
<thead>
<tr>
<th>Inoculations</th>
<th>Number between</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>3</th>
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<tr>
<td>Immunising time from final inoculations</td>
<td>Number and percentage Schick-negative.</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>Weeks</td>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>1 (100)</td>
<td>1 (25)</td>
<td>1 (2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
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<td>1 (25)</td>
<td>1 (47-6)</td>
<td></td>
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</tr>
<tr>
<td>6</td>
<td>1 (75)</td>
<td>1 (25)</td>
<td>1 (61-5)</td>
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<tr>
<td>8</td>
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<td>1 (25)</td>
<td>1 (71-4)</td>
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<tr>
<td>10</td>
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<td>1 (37-5)</td>
<td>1 (80-5)</td>
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<tr>
<td>12</td>
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<td>1 (25)</td>
<td>1 (92-4)</td>
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<td>1 (25)</td>
<td>1 (95-2)</td>
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</tr>
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<td>1 (25)</td>
<td>1 (95-2)</td>
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<tr>
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<td>1 (95-2)</td>
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<td></td>
</tr>
<tr>
<td>28</td>
<td>1 (50)</td>
<td>1 (25)</td>
<td>1 (95-2)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**REACTIONS ON INOCULATION.**

This matter is of considerable importance both to the individual inoculated and to a hospital administration. I have, therefore, kept careful records of all reactions, and the results are shown in Table II.

**Table II.**

|--------|----------|-------------------------------|--------|

27 years of age and, as might have been expected, a combined pseudo and positive reactor. She showed marked redness, pain, and swelling of the upper arm, vesiculation around the site of inoculation, and considerable malaise after the first inoculation. No further dose was therefore given.

**DIPHTHERIA DURING THE COURSE OF IMMUNISATION.**

Four nurses developed undoubted faucial diphtheria before immunisation was complete and negative Schick reactions obtained.

**Case 1.**—The onset was on the thirteenth day after her second inoculation—i.e., the day before the third dose was due. The Schick reaction was still positive 15 weeks after the onset of her attack, when she received a further 1 c.cm. of prophylactic. A second re-test four weeks later proved negative.

**Case 2.**—The onset in this case was five weeks after the last of three fortnightly inoculations, when she was still Schick-positive. No further doses were given, but the Schick reaction was negative eight weeks later. She remained a nasal and faucial carrier for six weeks.

**Case 3.**—This nurse received only two fortnightly doses of prophylactic and developed faucial diphtheria six weeks after the second. She became Schick-negative three weeks later.

**Case 4.**—In this instance an attack of faucial diphtheria occurred 12 weeks after the last of four doses. The antitoxin content of the blood was then estimated and found to be less than 1/50 of a unit per c.cm.

None of these cases had any reaction, either local or general, after the injections, and the attack of diphtheria was mild and uncomplicated in every instance. The mildness of these cases helps to dispose of the negative phase bogey.

It must be borne in mind that these cases all occurred in newly joined nurses who had come from country districts where the natural immunity is low and that, once in the hospital, they were continuously liable to heavy doses of infection.

**Conclusions.**

The preparation of diphtheria toxoid-antitoxin floccules used in this work is an efficient and rapidly immunising antigen which definitely protects against diphtheria. Its use in adults is not commonly followed by unpleasant reactions and, with rare exceptions, in the few instances when these do occur they are of a trifling character. A preliminary small injection of the prophylactic is unnecessary, and the best results are obtained by giving a course of three inoculations of 1 c.cm. each with an interval of two weeks between doses.

I would like to acknowledge my indebtedness to Dr. R. A. O'Brien, of the Wellcome Research Laboratories, for his kindness in supplying the prophylactic; to Dr. F. Hartley, of the National Institute for Medical Research, for kind assistance in regard to the literature of the subject; and to Dr. A. Joe, medical superintendent of the North-Western Hospital, for valuable suggestions.

**REFERENCES.**