IMPORTANCE OF "FEEDBACK" IN GONORRHOEA CONTROL*

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Omitting homosexuals, which are a separate consideration, there are three important factors in the epidemiology of gonorrhoea:

- (1) The promiscuous female infectious pool;
- (2) The males who contract gonorrhoea from them;
- (3) Other females infected by these males.

The promiscuous female will infect a number of men until, from her seeking advice on account of symptoms, from the protestations of infected males, from contact investigation, from the infection being aborted by antibiotics given for other reasons, or from ultimate spontaneous cure, her "quota" has been completed and she may be considered as withdrawn from the pool. The number of infected males per infected female may be termed the *male:female source ratio*, and much of the existing attempt at gonorrhoea control comprises the reduction of this figure by contact investigation to intercept the women before they have completed their maximum "quota", by epidemiological treatment, and by health education aimed at persuading promiscuous women to attend for examination.

An aspect of equal importance, but one which has received less attention, is the return of infections by the infected male to the female infectious pool, a process which may be described as "feedback".

Composition and Significance of "Feedback"

"Feedback" arises from the infected secondary female contacts of the infected male. Such contacts consist of three groups:

- (1) Those who may reasonably be regarded as non-promiscuous females (wives, fiancées, etc.). These usually require only patient persuasion to attend for examination but whether they attend or not is at least known and, as non-promiscuous persons, they seldom contribute to the female promiscuous pool;

- (2) Secondary contacts who are unknown or untraced;

- (3) Secondary contacts who are found to be promiscuous females.

"Feedback" may be calculated as the proportion of the sum of (2) and (3) which may (from the experience of (3)) be expected to have gonorrhoea (Fig. 1). This may be expressed as a percentage of infected males.

FIG. 1.—Composition of "feedback".

The significance of the figure for "feedback" is the critical point at different "male: female source ratios" at which the number of infections restored to the promiscuous female pool exactly balances

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those which remove themselves from it (Table I; Fig. 2).

TABLE I
PERCENTAGE OF MALE CASES INFECTING PROMISCUOUS WOMEN ("FEEDBACK") RESULTING IN EXACT RESTORATION OF FEMALE RESERVOIR AT DIFFERENT MALE:FEMALE SOURCE RATIOS

No. of Infected Promiscuous Women	Male:Female Source Ratio	No. of Men Infected	Critical Per cent. Feedback	No. of Promiscuous Women restored to Pool
100	10.0:1	1,000	10.0	100
100	9.0:1	900	11.1	100
100	8.0:1	800	12.5	100
100	7.0:1	700	14.3	100
100	6.0:1	600	16.7	100
100	5.0:1	500	20	100
100	4.0:1	400	25	100
100	3.0:1	300	33	100
100	2.0:1	200	50	100
100	1.0:1	100	100	100

FIG. 2.—Concept of "feedback". Example, at a male:female source ratio of 5:1, shows the same number of infections restored to the female promiscuous pool as were derived from it.

An existing "feedback" lower than this theoretical critical figure indicates that control is occurring, and conversely a higher figure signifies that control is deteriorating. Moreover, the higher the male:female source ratio, the lower is the critical "feedback" percentage at the point of neutral control (Fig. 3). When the male:female source ratio is high, only quite small differences in "feedback" may be required significantly to alter the promiscuous female pool (Table II; Fig. 4, opposite).

TABLE II
SMALL DIFFERENCES IN PERCENTAGE "FEEDBACK" REQUIRED SIGNIFICANTLY TO ALTER THE FEMALE POOL

Alterations in Female Pool (per cent.)	1.0	2.0	3.0
10.0:1	0.1	0.2	0.3
9.0:1	0.111	0.222	0.333
8.0:1	0.125	0.25	0.375
7.0:1	0.143	0.286	0.429
6.0:1	0.167	0.333	0.5
5.0:1	0.2	0.4	0.6
4.0:1	0.25	0.5	0.75
3.0:1	0.333	0.666	1.0
2.0:1	0.5	1.0	1.5
1.0:1	1.0	2.0	3.0

Thus, at any male:female source ratio of from 5:1 or above, an alteration of only a 0.4 per cent. (or less) in "feedback" will result in a change of 2 per cent. in the female infectious pool. Considered in

FIG. 3.—Critical percentage "feedback" at point of neutral control.

FIG. 4.—Effect of small changes in "feedback" in producing larger changes in infectious pool.

relation to the critical point of neutral control, this illustrates the "knife-edge" on which the control of gonorrhoea rests.

Factors which influence "Feedback"

"Feedback" is influenced by two factors: (a) promiscuity and (b) treatment failure rates (Fig. 5).

FIG. 5.—Promiscuity and treatment failure rates as factors in "feedback".

(a) *Promiscuity*.—The influence of promiscuity on "feedback" is a direct one (Fig. 6). For every infection passed by an infected male before treatment to a promiscuous female one infection is restored to the female infectious pool. (The fact that those females who are traced are immediately removed from the pool is not material to this argument.) If, for example, 10 per cent. of men transmit gonorrhoea to promiscuous women before being brought to

treatment, the "feedback" from the promiscuity factor is 10 per cent. At this level of promiscuity, and at a male:female source ratio of 10:1, there is no control as the number of infections restored to the pool exactly balances those derived from it.

FIG. 6.—Direct relationship of promiscuity to "feedback".

(b) *Treatment Failure*.—Male treatment failure rates also influence "feedback" by the number of infections restored to the pool after treatment has been given. The treatment factor also depends on promiscuity, for it is only the men with relapsing gonorrhoea who have intercourse with promiscuous women after treatment who are involved in

"feedback". The formula for the treatment failure factor is thus:

$$\frac{P \times T}{100}$$

where P is the promiscuity factor and T is the percentage treatment failure rate. The formula of "feedback" as a whole is:

$$P + \frac{PT}{100}$$

With a promiscuity factor of, for example, 10 per cent. and a treatment failure rate of 5 per cent., the "feedback" would be $10 + \frac{50}{100}$ or 10.5.

In other words the percentage treatment failure rate increases the "feedback" due to the promiscuity factor by a like percentage.

It is thus evident that the influence of treatment failure is substantially greater with higher promiscuity, and therefore with higher male:female source ratios, than when promiscuity is less. Thus the worse the situation of gonorrhoea control resulting from promiscuity, the greater will be the further deterioration of the situation resulting from less satisfactory treatment rates (Table III; Fig. 7).

TABLE III

EXTRA PERCENTAGE OF "FEEDBACK" RESULTING FROM DIFFERENT TREATMENT FAILURE RATES WITH VARYING PROMISCUITY FACTORS

Promiscuity Factor	Failure Rates (per cent.)					
	0	1	5	10	15	25
0	0	0	0	0	0	0
5	0	0.05	0.25	0.5	0.75	1.0
10	0	0.1	0.5	1.0	1.5	2.0
15	0	0.15	0.75	1.5	2.25	3.0
20	0	0.2	1.0	2.0	3.0	4.0
25	0	0.25	1.25	2.5	3.75	5.0

FIG. 7.—Contribution of treatment failure to "feedback".

At all promiscuity levels above 10, an alteration in the failure rate of 5 per cent. or more will change "feedback" by at least 0.5 per cent. This figure has already been shown to be more than sufficient to change the entire female promiscuous pool by at least 2.0 per cent. at male:female source ratios at and above 5:1. This indicates that male treatment failure rates have a much greater influence on the control situation than has perhaps so far been generally appreciated.

Assessment of "Feedback"

If the figures for "feedback" and also for the male:female source ratio could be accurately defined, the state of control at a particular moment could be precisely assessed. Knowledge of the "feedback" figure by itself could be similarly helpful if trends in the figure were studied. Those concerned with gonorrhoea control should therefore be encouraged to estimate such a figure wherever possible.

Data obtained by social workers at contact interviewing may give some indication of the state of affairs. The number of secondary contacts per 100 men should be ascertained and the non-promiscuous wives and fiancées deducted, leaving the untraced and the known promiscuous women, which may be regarded as potential sources of "feedback". The percentage of those traced and found to have gonorrhoea may be applied to both groups and this will indicate the "feedback" solely referable to the promiscuity factor.

The moiety due to treatment failure may be estimated from the male treatment failure rate which should also be obtained; as is well known, it is difficult to distinguish relapse from reinfection, but when calculated to a set pattern, treatment failure rates tend to be fairly stable.

It is apparent that by reducing "feedback" the whole female infectious reservoir is reduced. Measures aimed, therefore, at reducing promiscuity in males only, at encouraging the increased use of prophylaxis by males, and at reducing the treatment failure rates in males are theoretically capable by themselves of transforming the control situation in both sexes. If "feedback" could be entirely eliminated, the female reservoir of infection would gradually drain away as it was no longer replenished.

Summary and Conclusions

- (1) Gonorrhoea control depends on two factors: the number of men infected per promiscuous woman before she has completed her "quota" of infections (*male:female source ratio*) and

the number of infections returned to the promiscuous female infectious pool by these men ("feedback").

- (2) "Feedback" is composed of the secondary contacts of infected males both traced and untraced, less the non-promiscuous contacts (wives, fiancées, etc.), who—on the experience of those actually traced—may be expected to have gonorrhoea.
- (3) There is a critical percentage of "feedback" at different male:female source ratios at which the number of infections removed from the infectious female pool equals the number returned to it. The higher the male:female source ratio, the lower is this critical percentage.
- (4) Quite small differences in "feedback" may alter significantly the infectious female pool when the male:female source ratio is high. At all ratios from 5·0:1 and above, an alteration in "feedback" of only 0·4 per cent. (or less) will change the female pool by 2 per cent.
- (5) The most important influence on "feedback" is promiscuity and this influence is direct. "Feedback" is also influenced, in combination with promiscuity, by the male treatment failure rates. The formula for "feedback" is:

$$P + \frac{PT}{100}$$

where P is the percentage of male infections returned to the pool by contact with promiscuous females *before* he has been treated (promiscuity factor), and T is the treatment failure rate per cent. which contributes to feedback *after* he has been treated.

- (6) When promiscuity levels are high, the effect of treatment failure rates is greater than when they are low. At a promiscuity level of 10 per cent. or above, an alteration in the male treatment failure rate of 5 per cent. or above will change "feedback" by at least 0·5 per cent., this, as indicated above, may be more than enough to change the female pool by 2·0 per cent.
- (7) Steps should be taken to obtain data for the calculation of "feedback". Measures aimed at the reduction of "feedback" (*i.e.* discouragement of male promiscuity, increased use of prophylaxis by males, and perfection of treatment in males) are theoretically capable of by themselves of leading to the control of gonorrhoea

Importance du phénomène "réroaction" dans le contrôle de la gonorrhée

RÉSUMÉ

- (1) Le contrôle de la gonorrhée dépend de 2 facteurs: le nombre d'hommes contaminés par une femme jusqu'à ce qu'elle ait achevé sa part de contamination (rapport mâle sur source féminine) et le nombre d'infections retournées à la femme réservoir d'infection par les hommes (c'est ce qu'on appelle le phénomène "réroaction").
 - (2) La "réroaction" comprend les contacts secondaires des mâles contaminés, retracés ou non, moins les contacts avec leurs conjointes habituelles (épouses, fiancées, etc.) qui d'après l'expérience acquise par celles qu'on a retracées sont probablement contaminées.
 - (3) Il y a un pourcentage critique de "réroaction" pour différents rapports mâle sur source féminine d'infection, pour lequel le nombre des cas infectieux retirés du réservoir féminin d'infection égale celui qui y retourne. Le rapport mâle sur source féminine d'infection est élevé plus le pourcentage critique est bas.
 - (4) De petites différences dans la "réroaction" peuvent changer considérablement le réservoir féminin d'infection quand le rapport mâle/source féminine est élevé. A partir de rapports atteignant 5:1 et au dessus, un changement de 0,4% (ou moins) dans la "réroaction" changera le réservoir d'infection par 2%.
 - (5) Le facteur ayant la plus grande influence sur la "réroaction" est la promiscuité et cette influence est directe. Réroaction est également influencée en association avec la promiscuité par le taux des échecs de traitement chez l'homme. La formule pour "réroaction" est:
- $$P + \frac{PT}{100}$$
- où P est le pourcentage d'infections mâles retournées au réservoir par contact avec des femmes faciles avant traitement (c'est le facteur de promiscuité) et T est le pourcentage d'échec de traitement qui contribue à la "réroaction" après que le malade a été traité.
- (6) Quand le niveau de promiscuité est élevé, l'effet du pourcentage d'échec thérapeutique est plus grand que quand celui-ci est bas. Pour un taux de promiscuité de 10% ou plus, une modification dans le taux d'échecs thérapeutiques masculins de 5% ou plus changera la "réroaction" par 5% au moins; et ceci peut être plus qu'il ne faut pour modifier le réservoir d'infection féminin par 2%.
 - (7) Il faut obtenir des faits précis permettant de calculer la "réroaction". Les mesures qui tendent à réduire la "réroaction" (telles que décourager la promiscuité masculine, augmenter les mesures prophylactiques masculines et perfectionner le traitement chez l'homme) sont en principe capables d'assurer le contrôle de la gonorrhée.