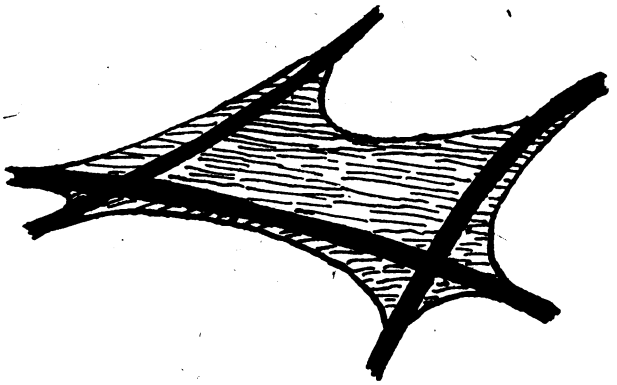

FIG. 3.—Saliva droplet adhering to wool fibres coated with fixanol.

forward. The impregnated blanket has a slightly smooth feel, it has no smell, and in routine hospital use for all blankets for a year there has been no indication of patients showing sensitivity to the treated blankets.

Discussion

The much higher frequency with which penicillin-resistant strains of staphylococci are recovered from hospital cases, as compared with those at home, is largely referable to cross-infection (Rountree and Thomson, 1949; Barber, Hayhoe, and Whitehead, 1949). Nasal carriers of such strains among hospital staff are also frequent, and there is a tendency for newly arrived nurses to acquire the prevailing phage type. Though staff may directly infect patients, both might, as postulated by the *Lancet* (1949), be infected by the hospital environment. The nose is an effective dust filter (StClair Thomson and Hewlett, 1896). This is by virtue of air turbulence and impaction of particles against the moist walls. Thus a ward nurse has something in common with a slit sampler.

It was of interest, therefore, to sterilize the hospital blankets for a period and to observe the effect on the incidence of carriers, and also of cross-infected wounds. Briefly, it may be reported that in three months there was no reduction in the carrier rate, while for wounds the small numbers left the matter in doubt, a certain amount of cross-infection still continuing. No doubt, as observed by Girdlestone, Bourdillon, and McFarlan (1951), there are a multiplicity of sources of infection. A wider trial is desirable in which the sterilization of clothes and other fabrics deserves consideration.

Whilst uncertainty remains on many points, it is not without importance that, as many have observed, pathogens are surviving for long periods in the woollen fabrics of our most immediate environment, and, moreover, that perhaps now this need no longer be so.

Summary

Cross-infection of wounds in a hospital has been investigated. Attention is directed to dust from blankets. From freshly laundered blankets *Staph. aureus* was frequently obtained, which organism readily survived the laundry process. During laundering bacteria pass from one blanket to the next.

Impregnation with cetyl pyridinium bromide (fixanol C) has been found a satisfactory way of sterilizing blankets. They remain, to a large extent, self-disinfecting.

I am indebted to Dr. W. H. James, medical superintendent of the Westwood Hospital, Beverley, for his valuable observation and advice on the clinical aspects; to Dr. W. Goldie, pathologist to St. James's Hospital, Leeds, for his most helpful criticism of the manuscript; and to Mr. A. Manby, senior technician, Westwood Hospital, Beverley, for preparation of the photographs.

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BACTERIOLOGY OF VAGINAL FLORA AFTER USE OF INTERNAL TAMPONS

BY

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The vaginal tampon is being used with increasing frequency for the absorption of the menstrual flow, but this subject has received little attention from the medical profession in this country, though there still may be a fair amount of prejudice against its use.

Correspondence for and against it appeared in the *British Medical Journal* (1938, 1939). For over 14 years Partridge (1939) had advised its use amongst her patients without there being any complaints or untoward results. Barton (1942) reported on the advantages of intravaginal tampons as menstrual guards.

The matter has been investigated fully by gynaecologists in the U.S.A. Sackren (1939) carried out an investigation on 21 patients and found no irritation in the vaginal or cervical tissues after the use of internal tampons. Thornton (1943) investigated 110 subjects for one to two years and arrived at the same conclusion. Karnaky (1941, 1943) claimed beneficial results in cases of sterility. Magid and Geiger (1942) investigated the bacterial flora in the vagina and cervix after the use of tampons in 25 women, over two menstrual periods,

and could find no appreciable difference. Baba (1946) studied the effect of intravaginal tampons on cervical erosions and vaginal discharges in 55 cases and concluded that, in the majority, their use had a favourable effect.

Genell and Lysander (1939) reported three cases of vaginitis which they attributed to the use of vaginal tampons. The report fails to give previous histories or the length of time the tampon was worn.

Present Investigation

This investigation was mainly concerned with the bacteriology of the vaginal flora following the use of the internal tampon. It was undertaken at the request of the visiting gynaecologists to the Elizabeth Garrett Anderson Hospital and with their co-operation. The object was to obtain information which could be given to patients, nurses, and doctors.

The original intention was to examine 100 volunteers over three monthly periods. Each volunteer was to undergo a pelvic examination by the gynaecologist before and at the end of the three months' use of vaginal tampons. In addition a vaginal swab was to be examined before and after each menstrual period for *p*H, bacteriology, and glycogen content, and to exclude any trichomonal or monilia infection.

Most of the volunteers were obtained from the gynaecological out-patient department, and, as many of these women were either fully employed during the day or were married, with young children, it was found impossible to get them to attend six times in three months. Thus in some cases a swab was taken before the first period and after three successive periods; but pelvic examination was made by the gynaecologist before and after completion of the study. Tampons were given to each subject, and complete instructions on their use were enclosed in each carton.

As these women were not quite normal, it was decided to enrol a number of normal women so that the results could be compared. I am indebted to Dr. Mary Barton for her co-operation, as she enlisted the help of a number of her patients, most of whom attended regularly over three months.

Since this investigation was started (over 13 months ago) 122 volunteers have been enrolled; 57 of these have completed three monthly periods or more, 17 have completed two monthly periods, and 26 have completed one monthly period; 22 have defaulted, 3 through failure to insert the tampon. In all, 100 volunteers completed one cycle or more. Six patients became pregnant.

Most of the volunteers were cases of infertility or dysmenorrhoea. A few had had small cervical erosions or complained of vaginal discharge. Only three of the cases showed a severe vaginitis; these are dealt with separately. Two volunteers were enrolled in rather unusual circumstances. The first reported at hospital thinking she had left a tampon in the vagina since her last menstrual period, over two weeks previously. This was incorrect. The second came with a complaint of offensive vaginal discharge, and on examination was found to have a retained tampon, which had probably been there since her last period three weeks before. In the hands of a careless person this is a possibility which is not likely to occur during the period, as the pad when saturated fails to fulfil its function, but, as quoted by Russell (1939), may occur at the end of the period.

All the volunteers were active women between the ages of 21 and 45 years. Eleven were single and 89 were married; 31 had not used tampons before; 69 had used them, but not all regularly.

The hospital patients suffering from cervical erosions or vaginitis were treated by the gynaecologists. Two swabs were taken on each occasion by rotating the swab round the anterior and posterior wall in the upper part of the vagina. One swab was used for estimating the *p*H by means of Johnson's *p*H papers, and then immersed in normal saline and incubated for a short time to be examined for monilia or trichomonads. The other swab was used for aerobic and anaerobic culture, and films were made for Gram stain and glycogen estimation. The glycogen content was examined by the method recommended by Siegler (1944), and was recorded as a percentage of the epithelial cells containing glycogen.

Bacteriology

Of the 100 volunteers, 63 showed no pelvic abnormality and were regarded as normal for the purposes of this study. One volunteer attended regularly for 10 menstrual periods, two for seven periods, and the rest for periods varying from one to four in number. The predominant organism found in the direct smear from 57 cases in this group was Döderlein's bacillus. The cultures gave a mixed growth of Döderlein's bacillus, coagulase-negative *Staphylococcus albus*, diphtheroid bacilli, and, occasionally, coliform bacilli. The bacteriology was very similar in the pre- and post-menstrual cultures. The remaining six volunteers in this group had an abnormal flora: four showed the presence of *Candida albicans* in direct smear and on culture, one had a persistent growth of a coliform bacillus associated with *Streptococcus faecalis*, and the sixth developed a trichomonal infection with vaginitis. The last-mentioned patient developed an irritating vaginal discharge one week before her second menstrual period, due to *Trichomonas vaginalis*. This was a recurrence of a previous infection. It cleared very quickly with acetarsol pessaries, and did not recur after her next menstrual period.

The four patients with *C. albicans* had no signs or symptoms of vaginitis (yeasts are sometimes found in the healthy vagina), and responded well to "mycil" pessaries in two cases, the flora returning to normal after treatment. The other two cases were not treated, and the infection was uninfluenced. The volunteer whose cultures gave a growth of a coliform bacillus showed no signs of vaginitis or cervicitis, and the flora remained abnormal throughout the investigation. In order to compare the results, post-menstrual swabs were taken from a number of normal young women who used the perineal pad for protection. The bacterial flora thus obtained showed no marked variation from that obtained in the tampon series.

The other 37 volunteers showed some evidence of pelvic disease. Thirty-three had a cervical erosion or showed signs of vaginitis, two had a minor degree of prolapse, one a cystic ovary, and another a fibroid uterus. The majority of the erosions were small and did not require treatment. The larger ones were cauterized at the beginning of the investigation, and some of them were subsequently painted with "negatol" 100%. Three cases, summarized below, showed a severe vaginitis. The bacteriology in the cases of simple erosion corresponded to a normal flora in 20 cases and an abnormal

flora in 10. Of the latter four showed *C. albicans* on smear and culture, one *Tr. vaginalis*, and two coliform bacilli and *Str. faecalis*. The three others have been classified as severe vaginitis. Three of the cases of infection with *C. albicans* were treated ; owing to illness the fourth attended during one menstrual period only. Two of the cases responded to treatment, and the infection did not reappear during the investigation. The fourth case did not respond to treatment: this patient had been attending hospital for several months with a chronic vaginitis, and her condition was uninfluenced by the use of vaginal tampons. One negative swab followed treatment of the trichomonal infection with acetarsol pessaries, but the infection recurred six weeks later, after an illness. She was then treated with acetarsol impregnated tampons, and the vaginitis cleared up completely ; it had not recurred two months later.

The vaginal *p*H of the cases varied from 4.2 to 5.4, but showed no marked difference in the post-menstrual period.

The glycogen content of the epithelial cells remained fairly constant in all cases. It was normal in some throughout, and low in others, especially in cases of infertility, but was uninfluenced by the use of the tampons.

Case Reports

The following is a summary of the three cases of severe vaginitis mentioned above in which vaginal tampons were used during the menstrual periods, over three months in Cases 1 and 3 and two months in Case 2.

Case 1.—This patient, aged 30, had used vaginal tampons for one year. She complained of an irritating vaginal discharge of one week's duration. Examination revealed a purulent discharge, with severe vaginitis but no erosion. The wet film from the pre-menstrual swab showed many pus cells, hyphae, and spores of monilia. Culture yielded a growth of *C. albicans*, a coliform bacillus, and *Str. faecalis*. The *albicans* infection responded to mycil pessaries, but the coliform infection was still present at the end of the second menstrual period. This was treated with "sulphatriad" pessaries for 10 days, and when the patient returned for her third pre-menstrual swab 11 days after her last treatment the flora had returned to normal, and remained so in her post-menstrual swab. A vaginal examination at this time showed that the vagina and cervix were healthy, and the patient was discharged.

Case 2.—The patient, aged 23, had used vaginal tampons regularly. She complained of an irritating offensive vaginal discharge of three weeks' duration. On examination per vaginam a retained tampon was found which had caused severe vaginitis and a cervical erosion. Unfortunately a swab was not taken. She was advised to douche and return in one week's time. She did not return until 14 days later, as her menstrual period had occurred, during which she had used vaginal tampons. Her discharge was then less offensive, and the vaginitis had abated. A swab taken yielded a mixed growth of a coagulase-positive *Staph. aureus*, coliform bacilli, and *C. albicans*. Treatment consisted of ichthyol and glycerin pessaries and douching. Three weeks later her pre-menstrual swab showed a scanty growth of *C. albicans*, but on examination there was no evidence of vaginal thrush. The post-menstrual swab one week later showed a normal flora. The vaginitis was much improved, the erosion had practically healed, and she had no complaints. Unfortunately this investigation finished at that time, but she was advised to return if her symptoms recurred. She had not done so three months later.

Case 3.—The patient, aged 42, had used vaginal tampons regularly. She complained of excessive loss at periods and vaginal discharge. Examination per vaginam showed a cervical polyp and cervical erosion with vaginitis. The polyp was removed and the erosion cauterized. Two months later this patient volunteered for the investigation. A large erosion was still present. A pre-menstrual swab yielded a growth of a coagulase-negative *Staph. albus* and *Bact. coli*. The erosion was painted with negatol 100%. Her second post-menstrual swab yielded a moderate growth of a coliform bacillus, but on examination the erosion was healing and smaller in size. The third post-menstrual swab showed a normal flora, and the erosion was almost healed.

These three cases responded to active treatment during the three months' investigation. Their progress compared very favourably with four similar cases in which the perineal pad had been used for protection.

Discussion

The principal organism associated with the healthy vagina is a pleomorphic non-sporing Gram-positive bacillus, variably anaerobic, identified by Döderlein in 1892. The vaginal flora found in the healthy adult is mixed, and staphylococci, enterococci, coliforms, and diphtheroids are also present (Wilson and Miles, 1946). Three grades of "cleanliness" are generally recognized in the vagina of the adult, and the classification of Heurlin (1941) is the one most usually accepted (Baird, 1950).

Grade 1.—Many epithelial cells, an occasional leucocyte, many Döderlein bacilli, and hardly any other organisms ; *p*H 4–4.6.

Grade 2.—Pus cells in excess of epithelial cells, few Döderlein bacilli, and a mixture of diphtheroids, cocci, and coliforms ; *p*H 4.5–6.

Grade 3.—Many pus cells, a few epithelial cells, no Döderlein bacilli. A host of other organisms—Gram-positive and Gram-negative cocco-bacilli, coliforms, Gram-positive bacilli, comma bacillus, and others ; *p*H above 6.

Heurlin mentions 37 varieties of bacteria which find their natural habitat in the genital tract. Many of these are saprophytic, and are seen only in direct smear. This may be accounted for by the bactericidal action of the vaginal secretion. With such a variety of organisms found naturally, the criterion adopted for the normal in this study has been the preponderance of Döderlein's bacillus found in smear and on culture; the criterion for the abnormal has been the excess of pus cells and organisms other than Döderlein's.

The organisms found in the post-menstrual cultures of the normal volunteers (63 in number) corresponded mainly to the Grade 1 flora. No appreciable difference was found in the bacterial flora of the pre- and post-menstrual culture. Döderlein's bacillus was the predominant organism in the direct smear, and grew well on culture, especially under anaerobic conditions. It was frequently associated with a coagulase-negative *Staph. albus*, and occasionally with diphtheroid bacilli and a scanty growth of coliform bacilli. Grade 2 flora was found in five cases, four of which showed a monilia infection on culture, and the fifth had a recurrence of a chronic trichomonal infection. In these five cases the pus cells were in excess of the epithelial cells, but in three of them the flora returned to grade 1 after treatment ; in two untreated cases it was unaltered.

The bacteriology of the 33 cases with cervical erosions or vaginitis corresponded to grade 1 (20 cases) and grade 2 (10 cases). Three cases of severe vaginitis showed a grade 3 flora.

An anaerobic streptococcus was found on several occasions, but this organism is a normal inhabitant of

the vagina (White, 1933). One strain was sent to the Streptococcal Reference Laboratory at Colindale, and the following report was received: "The streptococcus produced an α-haemolysis, was not heat-resistant, did not belong to any of the Lancefield groups, and formed no mucoid colonies on sucrose agar. It could not be identified."

The anaerobic streptococcus isolated by White was a strict anaerobe, and very slow-growing, requiring two to four days' incubation. None of these organisms was isolated, probably because the cultures became overgrown by contaminants if incubated longer than 48 hours. No gas was formed by any of the anaerobic streptococci, mannite was not fermented, the organism did not grow on MacConkey's medium, and there was no evidence that this organism was pathogenic. *Str. faecalis* was found in association with coliforms on three occasions. In one case the cervix and vagina appeared healthy.

Ten cases were found to have *C. albicans* on culture; only four of these had a vaginal discharge or showed evidence of vaginal thrush. Six cases had no symptoms. Two volunteers had a trichomonal infection: one was a recurrence of a previous infection during the period under study, but it cleared up very quickly with acetarsol pessaries, and did not occur after the next menstrual period. The other was a recent acute infection. None of the other volunteers acquired monilia or trichomonal organisms during the period of study or developed erosions or vaginitis as a result of using the internal tampon.

Erosions

The findings have already been summarized. There was no aggravation of the condition or delay in healing following the use of tampons in the patients who had cervical erosions. All the erosions were reduced in size if not completely healed, and the bacterial flora, where abnormal, had returned to normal at the end of the period under study. The vaginal tampon, when properly used, is not in contact with the cervix but only with the vaginal wall, which is self-protecting (Cruickshank and Sharman, 1934). Three cases had signs of severe vaginitis and one of them had a large erosion, the vaginitis in one case being caused by a retained tampon. They were medically treated by the gynaecologist, and all continued to use tampons for protection. In each case the underlying cause responded to treatment, and did not recur, which proves that the internal tampon does not act as an irritating foreign body. All had a grade 3 flora at the beginning of the study; this reverted to grade 1 at the end. The rate of healing compared favourably with four control cases in which the perineal pad was used.

The glycogen content was estimated as a percentage of the epithelial cells in the smear containing glycogen. It was found to be low in some cases of infertility, but was uninfluenced by the use of tampons. Normally most of the epithelial cells should contain glycogen.

The *p*H was less acid than the normal grade 1 flora in some of the patients, probably owing to the fact that the swab was taken from the upper part of the vagina, to avoid contaminants found in the lower part. There was no appreciable alteration in the *p*H in the pre- and post-menstrual phases.

The volunteers who had not previously used tampons stated that they were comfortable to wear and did not cause the irritation usually found with the perineal pad. A few complained that they did not give enough protection at the beginning of the menstrual period, and that a perineal pad was required as well. There were no complaints of an excessive flow of blood on withdrawal, of difficulty in removal, or of any odour associated with their use. The average number employed in one cycle was ten.. Two volunteers stated that they required 15–18 tampons.

Summary

A series of 100 women used vaginal tampons for protection during the menstrual period over three to ten successive periods in 57 cases, two-monthly periods in 17 cases, and one-monthly period in 26 cases. Smears and cultures taken before and after each period showed no appreciable change in the bacterial flora of the vagina.

A study was made of 33 unselected cases of cervical erosion or vaginitis in which internal tampons were used. Healing of the erosions was not adversely affected; it compared favourably with a control series using the perineal pad. In three of the cases the bacterial flora corresponded to grade 3 at the beginning of the study, but returned to the normal grade 1 at the conclusion.

There was no evidence of local irritation or inflammation caused by the use of internal tampons. No appreciable alteration in the vaginal *p*H or in the glycogen content of the epithelial cells was noted. A retained tampon may cause damage to the vagina or cervix, and patients should be warned to remove the soiled one before inserting a fresh one. Removal is particularly important at the end of the menstrual period.

There was no evidence that vaginal tampons are prejudicial to health.

My thanks are due to the gynaecologists of the Elizabeth Garrett Anderson Hospital, in particular to Miss Josephine Barnes for her great help and encouragement throughout the study, and for her most useful criticism of this paper. Tampax Limited aided the research work by a grant, and supplied the tampons.

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The Ministry of Health is lifting the 21-year-old ban on importing parrots, as from January 8. The regulations have been revoked because there has been no significant recurrence of psittacosis in this country since the world-wide outbreak which led to the ban. Furthermore, research has since shown that psittacosis, which was originally believed to be confined to the parrot species, also occurs in seagulls, pigeons, ducks, turkeys, and similar birds. Moreover, modern drugs, such as penicillin and the new antibiotics, have largely robbed the disease of its dangers. Only one death has occurred in England and Wales in the last 10 years. The lifting of the ban does not affect any other legal requirements. For example, anyone importing a parrot from certain countries will still need a Board of Trade licence to import a seed-eating bird.