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Dr. Wentworth is chief; Mrs. Miller is nurse epidemiologist; and Mrs. Wentworth is bacteriologist-in-charge (Research Unit), Division of Communicable Diseases, State Department of Health, Columbus, Ohio.

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CONTROL OF AN OUTBREAK OF STAPHYLOCOCCAL INFECTIONS AMONG MOTHERS AND INFANTS IN A SUBURBAN HOSPITAL

F. Robert Fekety, M.D.; Leon Buchbinder, Ph.D., F.A.P.H.A.; Elmer L. Shaffer, Ph.D., F.A.P.H.A.; Sidney Goldberg; H. Preston Price, M.D.; and Louis A. Pyle, M.D.

THIS REPORT describes an epidemic of staphylococcal disease affecting infants and mothers at the Valley Hospital in Ridgewood, N. J., from February to June, 1957. Thirty-three (10 per cent) of the 319 live births at the hospital during the epidemic were complicated by suppurative illnesses. Excluding carriers of the epidemic strain from the nursery and changing certain nursery procedures and technics temporarily controlled the epidemic. Despite the continuation of these measures, a second outbreak occurred. It ended when a carrier of the strain was found and excluded from contact with infants.

The Valley Hospital is a modern, attractive 118-bed general hospital; an average of 120 deliveries are performed there each month. The nursery consists of three connecting rooms with a capacity of 28 full-term infants in partitioned cubicles; it provides a minimum of 24 square feet of space for each infant. Additional rooms are provided for premature infants, isolation, examinations, formula preparation, utility procedures, and as workrooms for doctors and nurses. The entire nursery is on one floor and is adjacent to the maternity unit. Prior to this study, air was supplied by a partial-recirculation air conditioner equipped with filters and an ultraviolet light.

Epidemic Background

Suppurative disease in infants and mothers was first noted in the latter part of 1955, whereupon isolation and aseptic technics were revised. Nursery linen was autoclaved, frequent handwashing with hexachlorophene soap was required, individual bassinet technics were adopted, gown and mask technics were improved, and the nursery policy book was revised. A decline in the incidence of illness was subsequently noted.

Pustular infections were noted again in September, 1956. Despite the daily bathing of infants with hexachloro-

phene soap, suppurative illnesses were diagnosed in the nursery nearly once each week. In November, two infants born at the Valley Hospital died of staphylococcal pneumonia in other hospitals. Prompted by Shaffer's report[27] that the majority of such hospital-acquired newborn illnesses began after discharge, the staff contacted local physicians and learned of other cases of empyema, pneumonia, breast abscess, and pyoderma. It was estimated that 10 per cent of all deliveries in November were complicated by suppurative disease in either infant or mother.

A trial of prophylactic erythromycin was begun in December, 1956. As recommended by Shaffer,[27] erythromycin (44 mg/kg daily in six divided doses) was administered to all infants beginning immediately after birth and was continued for seven days. Infants were discharged on the fourth post-partum day. Nursery personnel were advised to take oral erythromycin during this period. A sharp reduction in the number of clinical infections in the nursery was noted for about two weeks, but home infections were still reported. When 11 infants developed diarrhea on the above regimen, the dosage of erythromycin was reduced to 35–40 mg/kg daily. Hexachlorophene bathing was discontinued at the same time for other reasons. Subsequently, four infants receiving erythromycin developed pyoderma while in the nursery, and another developed a breast abscess. In addition, erythromycin-resistant staphylococci were obtained from two asymptomatic infants. Despite the fact that the infant population was being treated with erythromycin, these organisms (later shown to have the bacteriophage pattern 52/42B/80/81) did not become established in the nursery, as they might have been expected to do if staphylococci were being transmitted from infant to infant.

When it became apparent that erythromycin had not eradicated the strain from the nursery, its use was discontinued; and the hospital requested assistance from the New Jersey State Department of Health. The present study was begun in February, 1957, as a cooperative effort of the Valley Hospital staff, the New Jersey State Department of Health, the Bureau of Laboratories of the New York City Health Department, and the Communicable Disease Center of the U. S. Public Health Service.

Closing the nursery was considered at the beginning of this investigation, and was rejected because it has not been shown to be a permanent solution to this problem. Since the application of many generally recommended control measures had failed to check the epidemic, the authors felt that a period of study aimed at defining the sources of the causative agent and estimating the magnitude of the problem should be the basis for further control measures.

Methods

Sterile cotton swabs were used to culture the anterior nares of all infants at the time of discharge from the hospital. A culture from the skin near the umbilicus was usually obtained at the same time. Chapman Stone agar (Difco) was used for the primary isolation of staphylococci which were then tested for coagulase production by the tube method, and for antibiotic sensitivity by the disk method. Staphylococci were typed by the bacteriophage methods described by Williams and Rippon,[31] and Blair and Carr,[4] as modified by Goldberg.[11] All lesions were cultured on blood agar. Cultures were obtained weekly from the anterior nares of all personnel with regular assignments to the nursery or delivery room.

Two methods were used to detect illnesses which began after discharge. The physician caring for the infant was ques-

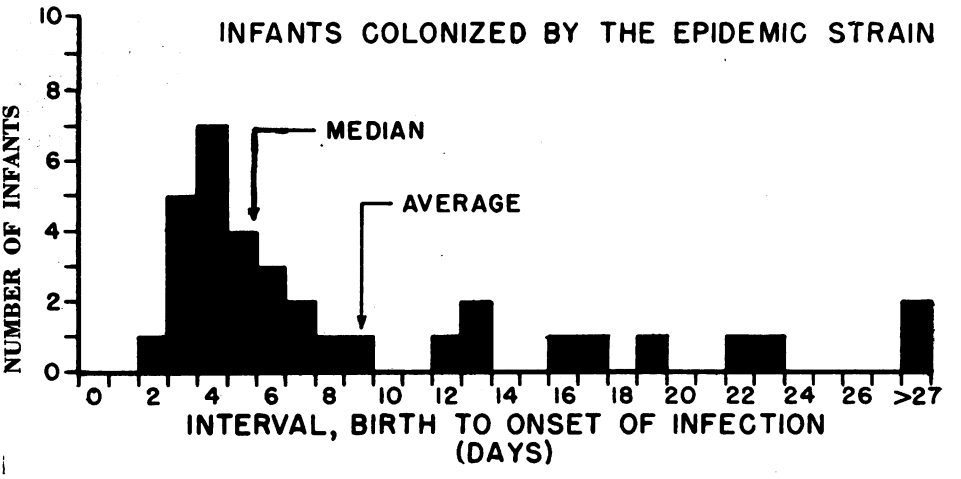

Figure 1—Time of Onset of Infant Staphylococcal Infections

tioned by telephone approximately six weeks after discharge about the health of the infant. Approximately half of the mothers were questioned by telephone approximately six weeks after discharge about the occurrence of suppurative illness in themselves or their infants. The technics used were similar to those described by Ravenholt.[22, 23]

Results

Rate and Types of Infection

During the entire period of study (February to August, 1957) 844 live births were recorded and 34 suppurative illnesses were observed. Ten per cent of the 319 deliveries performed during the epidemic periods were complicated by staphylococcal disease. Table 1 shows the types of staphylococcal disease associated with this nursery over a one-year period.* Sixty-five suppurative illnesses were observed; 80 per cent of these occurred in infants. Fifty-three illnesses in infants were diagnosed; pyoderma was the most common disease manifestation. Eight infants and seven mothers developed breast infections. The majority of these mothers had breast fed their infants. Five infants developed pneumonia, empyema, or septicemia with internal abscesses, and only one of these infants survived. As shown in Figure 1 infant illnesses began on the ninth or tenth day of life on the average (median 5.5 days). Approximately half of the infections were diagnosed before the infant was discharged from the hospital. Maternal breast infections began on an average of 22 days post-partum. These observations are consistent with those of Wysham and others suggesting that puerperal mastitis is frequently due to organisms acquired in the nursery and transmitted by in-

Table 1—Staphylococcal Disease in Mothers and Infants, September, 1956, Through August, 1957

Illness	Number
Infant pyoderma *	36
Infant breast abscesses	8
Infant pneumonia, empyema	4
Septicemia, internal abscesses	1
Deaths (due to the above)	4
Maternal skin infections	5
Maternal mastitis, breast abscesses	7

* Includes pustules, furunceles, abscesses, bullous impetigo, etc.

* September, 1956, through August, 1957.

fants to their mothers, and that breast feeding appears to predispose the mother to this complication.[23, 27, 28, 33]

The Etiologic Agent

Staphylococci obtained from 28 suppurative lesions which had their onset in the nursery were typed, and 25 of them (89 per cent) had the bacteriophage pattern 52/42B/80/81 (hereafter referred to as the epidemic strain, or strain 52/42B/80/81). The organism was hemolytic, coagulase-positive, and produced a yellow pigment. It was resistant to penicillin, streptomycin, and the tetracyclines; and was sensitive to chloromycetin, erythromycin, and novobiocin. A strain which is probably identical to this one has recently been implicated as the cause of more than 40 similar epidemics in the United States, Canada, Australia, New Zealand, and Germany.[27]

As shown in Table 2, 49 infants were colonized in the hospital by the epidemic strain; 17 of them (35 per cent) developed a suppurative illness due to the organism while in the hospital, and 17 additional infants (35 per cent) developed clinical infections at home. In all, 70 per cent of the infants colonized by the strain eventually developed disease. In comparison, 92 infants were colonized by other coagulase-positive staphylococci, and only three of them (3.3 per cent) developed lesions during the same period of observation.

Sources of the Epidemic Strain

Infants—Coagulase-positive staphylococci were obtained at the time of discharge on the third or fourth post-partum day from 141 (17 per cent) of the 844 infants born during this study. During the first seven weeks of this study 32 infants in the nursery (15 per cent) were colonized by the epidemic strain; 12 developed pustular disease prior to discharge and were transferred to isolation facilities. Colonized or clinically infected infants were present in the nursery throughout this interval, and transmission of the organism from one infant to another could not be ruled out as a means of perpetuation of the epidemic.

Mothers — Many investigators have stressed the lack of similarity between

Table 2—Illness Rate Following Colonization of Infants by Two Kinds of Staphylococci—February 21 to August 21, 1957

	Staphylococcus Colonized	
	Strain 52/42B/80/81	Other Coagulase-Positive Staphylococci
Number of infants colonized (nursery)	49	92
Number of clinical infections which began in the nursery	17	1
Number of clinical infections which began at home	17	2
Number developing clinical infections	34	3
Per cent developing clinical infections	70%	3%

the strains of staphylococci carried by mothers on admission to the hospital and the strains acquired by their infants in the early post-partum period.[1, 3, 6, 12, 14, 19, 33] When a woman afflicted with an abscess caused by the epidemic strain was admitted to the obstetrical service, we were prompted to reconsider mothers as sources of the epidemic strain. Nasal cultures were obtained from 157 mothers at the time of admission to the hospital. Forty-one (26 per cent) carried coagulase-positive staphylococci, and two (1.3 per cent) carried the epidemic strain. One of the maternal carriers gave a history which suggested that she had acquired the epidemic strain during a prior hospitalization on the obstetrical service. Two infants (1 per cent of all infants, or 8 per cent of the infants colonized by staphylococci) acquired strains which were identical to their mothers' admission strains. Neither of these were the epidemic strain. The transmission of staphylococci from one mother to the infant of another was not demonstrable.

The Environment — Approximately 150 cultures were obtained from walls, floors, cotton blankets, bassinets, resuscitators, tracheal catheters, doorknobs, sink handles, air conditioner vents and filters, and so on, by means of moist cotton swabs. Staphylococci of the epidemic strain were isolated from three dust samples and from the blanket of an infant colonized by the epidemic strain.

Air—Blood and Chapman Stone agar settling plates were exposed to the air for one hour in various parts of the nursery on two occasions when nursery activity was maximal. Although a plentiful growth of bacteria was observed on them, only one of 60 settling plates yielded staphylococci of the epidemic strain. That plate had been exposed in the isolation room next to the bassinet of an infant with a pustular infection.

Nurses—Approximately 700 nasal cultures were obtained during this investigation from nurses, aides, and porters who had regular duties in the nursery or delivery room. Coagulase-positive staphylococci were isolated on one or more occasions from the anterior nares of about three-fourths of the persons studied, although only about 40 per cent of the individuals cultured during any one week carried them. A few persons never carried staphylococci. Others carried a strain for brief periods only (transient carrier); and the same strain was repeatedly isolated from certain individuals (permanent carrier). A person who harbored the epidemic strain on two occasions was considered a permanent carrier until proved otherwise. Five persons working in close contact with infants were found to be asymptomatic permanent carriers of the epidemic strain during the first seven weeks of this study. When these individuals were later excluded from the nursery they did not rapidly lose the strain. We could not isolate the epidemic strain from the hands of permanent nasal carriers who washed their hands with hexachlorophene soap.

Evidence that nurses are important sources of the organisms acquired by infants was obtained by analysis of the strains prevalent in the nursery during interepidemic periods. Coagulase-positive staphylococci were acquired by 92 infants during these periods; 62 isolates (67 per cent) were typable. Several nurses who were carriers of nontypable strains were assigned to the nursery, and were possible sources of the nontypable strains. Of the 62 typable isolates, 51 (82 per cent) were identical with the strains of permanent carriers working in the nursery when the organisms were isolated from infants. Some of the infant strains which could not be traced to nursery personnel were traced to mothers.

The epidemic strain was the only strain which was prevalent in the nurs-

ery for prolonged periods. It was frequently observed that a strain which was predominant in the cultures obtained from infants in one week was entirely absent from the nursery in subsequent weeks. There was no tendency for a strain to localize in one room, which suggested that air-borne spread was not frequent.

Doctors—We did not undertake an intensive cultural study of doctors. During a period when 17 infants were colonized by the epidemic strain, the outbreak could not be related to any single doctor. None had cared for more than five of the affected infants.

Other Parts of the Hospital—Children on the pediatric ward were occasionally infected with the epidemic strain. It seemed likely that personnel carriers of the epidemic strain were working on the pediatric ward, even though some of these illnesses were acquired outside the hospital.

Staphylococci were isolated from 71 outpatients at the hospital (Table 3). The majority of these isolations (59 per cent) were the epidemic strain, and were related to a recent contact with hospitals. Infants born at the hospital and their close relatives returned for treatment of suppurative illnesses due to the epidemic strain. Nine infants who were born at other hospitals in New Jersey were treated for disease caused by the epidemic strain. Five persons without any hospital contact in the recent past presented infections due to the epi-

Table 3—Sources of Coagulase-Positive Staphylococci Isolated from Outpatients at the Valley Hospital—February 21 to August 21, 1957

Source of Culture	Staphylococci Isolated: Phage Type 52/42B/80/81	Staphylococci Isolated: Other Phage Types
A. From Clinical Infections:		
Suppurative lesions in infants born at the Valley Hospital (onset after discharge from the hospital)	16	3
Suppurative lesions in close relatives of infants born at the Valley Hospital	3	0
Suppurative lesions in infants born at other hospitals	9	0
Suppurative lesions in persons with no known recent hospital contact prior to the onset of their illness	5	15
B. From Nose, Throat, or Skin Cultures:		
Asymptomatic close relatives of infants born at the Valley Hospital	9	0
Routine cultures from persons with no known recent hospital contact prior to the onset of their (non-suppurative) illness	0	11
Total	42	29

demic strain; but most persons with no prior contact with hospitals yielded staphylococci which were not the epidemic strain.

Control Measures

Since the methods of transmission of the epidemic strain were not defined by the cultural studies described above, the relative importance of personnel carriers and the infant reservoir in the perpetuation of an epidemic could not be ascertained. Control measures were therefore aimed at preventing the spread of staphylococci from both groups.

Nursery personnel who were permanent carriers of the epidemic strain were assigned to other parts of the hospital. Assignments with minimal patient contact were chosen for these carriers.

Other measures were aimed at preventing the transmission of staphylococci from infant to infant. It has been shown that infants who are more than three days old are particularly likely to be carriers of staphylococci.[7, 29, 33] Therefore, the hospital began to discharge infants and mothers on the third post-partum day. If complications prevented early discharge, the infant was transferred to other facilities.

As a result, it became possible to utilize the three nurseries as separate units, and to segregate infants by date of birth (although the nursing staff was common to all of them). All infants were admitted to one room until it was full or until 48 hours had elapsed, at which time the room was closed to further admissions. In this way, infants were directly exposed only to others of approximately the same age. When all newborns had been discharged from a nursery, it was cleaned, washed with a disinfectant, and aired until it was again needed (usually 24 hours).

Finally, changes in aseptic technics and equipment were adopted. Most important, perhaps, was the change to wetmopping and damp-dusting in the nursery (to the exclusion of vacuum cleaning, which has been shown to create air currents). The ventilating system was changed to one using 100 per cent outside air (no ultraviolet light was used). Improved hand-washing and foot-operated diaper disposal facilities were provided. Unauthorized personnel were barred from the nursery. Formulas were prepared by terminal sterilization at 212°F for 25 minutes (as compared with 20 minutes previously). Careful hand-washing, between infants, with a hexachlorophene detergent was stressed. While all persons who were not assigned to the nursery were required to wear masks and gowns upon entering it, the nursery personnel were not required to wear masks.

Effect of Control Measures on the Course of the Epidemic

Figure 2 shows the course of the epidemic during the 26 weeks of study. Only illnesses which began in the nursery and were caused by the epidemic strain are shown. Figure 2 also shows the number of isolations of coagulase-positive staphylococci and of strain 52/42B/80/81 that were obtained from the nursery each week. Home follow-up showed that the incidence of disease in the nursery was a reliable index of the morbidity at home during this study (Table 4). When a high incidence of disease was observed in the hospital, a high incidence after discharge was observed; and the converse was also true.

Two distinct epidemic waves were observed. The first has already been described; it occurred during the period from February 21 to March 28 when the initial epidemiologic investigations were performed. Most of the control measures were instituted during the latter part of March. By the week of March 28 all known carriers of the epidemic strain had been excluded from the nursery, and the early discharge of

Table 4—Relation of the Rate of Colonization and Illness in the Hospital to the Rate of Illness at Home

	Epidemic Periods February 21–April 10 May 23–June 12		Inter-epidemic Periods April 11–May 22 June 13–August 21	
	Number	Per cent of Deliveries	Number	Per cent of Deliveries
Total Deliveries	319		525	
Infants colonized by the epidemic strain in the hospital	47	15	2	0.4
Epidemic strain illnesses detected in the hospital	17	5	0	...
Epidemic strain illnesses detected by follow-up methods	16	5	1	0.2
Total illnesses due to the epidemic strain	33	10	1	0.2
Illnesses at home detected by follow-up methods (without regard to cultural proof)	57	18	14	2.7
Total illnesses in hospital and home	74	23	14	2.7

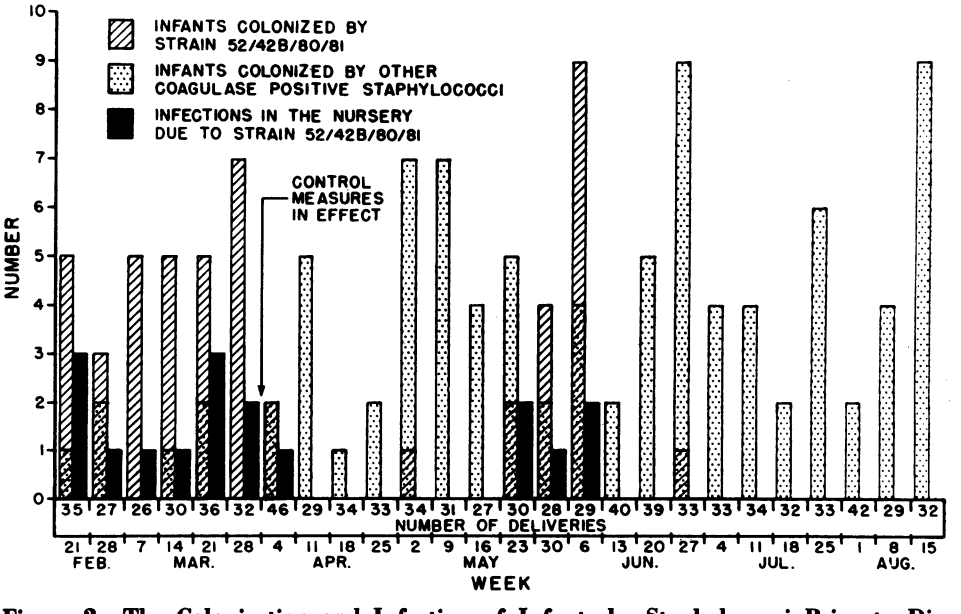

Figure 2—The Colonization and Infection of Infants by Staphylococci Prior to Discharge from the Hospital February 21 to August 21, 1957

infants was begun. As shown in Figure 2, a marked reduction in the incidence of colonization and infection by the epidemic strain in the nursery was observed in the following seven weeks. Only one infant was colonized by the strain, and none developed illness in the nursery during the period from April 11 to May 22.

Despite these measures, however, a second outbreak was observed from May 23 to June 12. Fifteen (17 per cent) of 87 infants born then were colonized by the epidemic strain, and five infants (6 per cent) developed suppurative illnesses. During this outbreak the isolations of the epidemic strain were distributed in a random way through four nursery rooms. Air-borne spread from infant to infant might have been expected to localize the isolations in one room during brief intervals. That they were not so localized suggested that air-borne transmission of the organism was infrequent.

Three possible explanations for the outbreak were obtained. The first isolation of the strain in the outbreak was from an infant delivered by Cesarean section in the operating room. A nurse and an aide working there were found to be carriers of the epidemic strain. Two women who were carriers of the epidemic strain were admitted to the maternity unit shortly before this outbreak began. Neither of their infants acquired the strain while in the hospital. Finally, a part-time nursery worker, not previously cultured, was found to be a permanent carrier of the epidemic strain during the outbreak. The mothers and operating-room personnel who were carriers had no direct contact with the infected infants, but the nursery worker did have contact with them. The outbreak terminated abruptly when she was assigned to another part of the hospital.

From July 1 to October 31 no infants in the nursery were colonized or infected by the epidemic strain (Figure 2). Home follow-up confirmed that the epidemic was under control (Table 4). In addition, 117 infants born at the hospital from August 5 to September 8 were seen at home by members of the local Visiting Nurse Association approximately two weeks after discharge. Nasal cultures were obtained from infants and mothers. No illnesses due to the epidemic strain were detected. One mother and her infant were found to be carriers of the epidemic strain, but it did not appear that the strain had been acquired during their recent hospitalization.

As Figure 2 shows, the rate of colonization of infants by staphylococci of all types was not affected by the control measures instituted in March. Therefore, a strain specific control measure was probably responsible for the eradication of the epidemic strain from the nursery. The only measure affecting the epidemic strain exclusively was the removal of carriers of the strain from the nursery.

Discussion

While staphylococcal infections of the newborn have been recognized for many years, they seem to have become more frequent within the past decade, and they now constitute a major public health problem.[23] Many observers have attributed the increase in the frequency of these infections to the widespread use of antibiotics, with the resultant emergence of antibiotic-resistant staphylococci, and the creation of hospital personnel and patient reservoirs of these organisms.[18, 32] A great deal of interest in the epidemiology of staphylococcal infections has been shown in the past few years as a result of the finding that staphylococci can be typed by means of bacteriophages.

There is ample evidence to support the belief that nurses are the most fre-

quent sources of the staphylococci which colonize infants in nurseries under nonepidemic conditions. Allison and Hobbs,[1] Rountree,[24, 25] Webb,[30] McCartney and Yates,[20] Barber, et al.,[3] and Baldwin, et al.,[2] noted the high frequency with which the strains isolated from infants were present in personnel working in the nursery. However, it has been suggested that the colonization of the staff by a given strain may be the consequence rather than the cause of infant colonization by the same strain. Baldwin, et al.,[2] noted the frequency with which personnel carriers of strains which are prevalent in a nursery lose that strain when they are relieved of nursery duties. However, the same authors have demonstrated that the strains acquired by infants were commonly carried by nurses prior to the introduction of the strain into the infant population. Similar observations were made during the present study.

The importance of personnel carriers in the perpetuation of an epidemic is uncertain. The assignment of a carrier of a given strain to a nursery has occasionally resulted in an outbreak of infections due to that strain (previously absent from the nursery).[1, 3, 6, 14, 24] Several outbreaks have been controlled by detecting and eliminating carriers.[1, 10, 15] The control of epidemics by the local antibiotic treatment of the personnel nasal carrier has been reported.[9, 24]

Others have assigned a minor role to the personnel carrier once the strain has been introduced into the nursery, and feel that transmission of the organism from infant to infant is of greater importance.[2, 6, 23, 30, 33] Epidemics have been controlled by measures which were not aimed at the elimination of personnel carriers.[5, 23] Wysham described an epidemic due to the 52/42B/81 strain in which no personnel carriers were detected.[33]

Jellard [17] implicated the infant's umbilicus in the spread of staphylococci. She observed a lower colonization rate in the nursery when an antiseptic solution was used in the care of the umbilical stump, which was likened to an infected wound. The hands of nursery personnel have been considered a likely vector. Allison and Hobbs [1] were unable to detect any permanent hand-carriers in the absence of nasal carriage of the organism, but Jellard [17] found that transient hand-carriers of strains endemic to the nursery were common in spite of frequent hand-washing. Several investigators found that the use of sterile rubber gloves by nursery personnel had no effect on the course of an epidemic.[9, 26, 27] Bathing infants daily with hexachlorophene soap has apparently reduced the spread of staphylococci,[2, 12] presumably by preventing colonization of the skin and by reducing the frequency of transmission via hands and the air.

It is important to recognize that even if infant to infant transmission were of primary importance in an epidemic, there are a multiplicity of virtually unexplored ways in which it could be operative. Though staphylococci of the epidemic strain have been found in the air and dust of nurseries, a causal relation between the number of organisms and the incidence of infection has never been demonstrated. Perry, Siegel, and Rammelkamp [21] studied an analogous situation and found that group A streptococci recently deposited in dust by individuals harboring them during epidemics produced no infections when inoculated into the respiratory tract of presumably susceptible men. They concluded that simple survival of the organism in dust does not indicate that growth on the mucous membranes of susceptible hosts will occur. Hare and Thomas [13] argued that the direct expulsion of staphylococci into the air in droplets or droplet nuclei from the anterior nares is less important than the

indirect route involving egress in nasal secretions and the secondary contamination of skin, clothing, bedding, and so on. This indirect mechanism would serve to emphasize the importance of maintaining strict aseptic and isolation technics in the nursery in order to prevent the spread of staphylococci from both infant and personnel carriers. It should not be assumed that the only solution to the problem of nursery staphylococcal infections lies in elaborate methods for the control of airborne infectious agents. The available evidence suggests that more realistic and readily attainable practices will suffice to prevent hospital infections.

When the investigation reported here is viewed in relation to those discussed above, two general impressions concerning staphylococcal infections of the newborn stand out. The first is that infants in nurseries represent a population which is highly susceptible to epidemics of staphylococcal infections; that characteristic and unusual staphylococci are the principal offenders in this country at the present time; and that the strain may be introduced into the nursery in a multitude of ways. The fact that mothers infrequently transmit staphylococci to their infants while in the hospital loses some significance when it is realized that the epidemic strain can be isolated from persons in the general community; that it can be transmitted to an infant by its mother; and that an epidemic can probably be initiated by one infected infant. In addition, it appears that strain 52/42B/80/81 can be isolated from patients in all parts of hospitals,[8] and that nursery personnel are frequently exposed to such patients or the staff caring for them. These facts have considerably increased the difficulty of preventing the introduction of the strain into a nursery.

Second, there are probably many ways in which an epidemic can be perpetuated in a nursery, and they are probably frequently operative in combination. Therefore, there is no single simple method of control which can be recommended for application to all epidemics.

It is not unlikely that one nurse carrier might be responsible for a prolonged outbreak if her contact with infants were of a sufficient nature and degree. A significant number of infants may be infected by a carrier who is easily overlooked. Baldwin, et al.,[2] reported such an instance. A strain that predominated in their nursery for a month was "finally traced to anesthetist in the delivery room," and the strain disappeared from the nursery when she was transferred from the obstetrical service. The evidence strongly suggested that a similar situation was observed during the present study. From the work of Hare and Thomas,[13] it appears that certain asymptomatic carriers are more dangerous than others. A carrier with an overt infection is probably extremely dangerous, and it hardly seems necessary to emphasize the importance of excluding such persons from the nursery. Infant to infant spread via the air and dust might be particularly encouraged by overcrowding, inadequate ventilation, and poor housekeeping. Improper technics and certain kinds of skin or umbilical care might facilitate infant to infant transmission via fomites and hands. Infant to infant spread might operate by the production of personnel carriers (either permanent or transient) secondary to infant contact. Finally, it should be mentioned that the perpetuation of an epidemic might be dependent upon certain strain characteristics such as high infectivity, increased growth and surface-survival rates, or the ability to compete favorably with other microorganisms for host sites.

Nonetheless, the complexity of the situation does not signify that control is impossible. While the possibility

must be entertained that the control of the epidemic reported here was a result of factors unrelated to the control measures instituted, temporal relations make this unlikely. Some of the measures instituted here are not applicable to all nurseries, and are not recommended for general adoption. However, the experience gained in the study of this epidemic has led the authors to conclude that it is possible to control and prevent nursery staphylococcal infections if personnel carriers of the epidemic strain are relieved of duties in the nursery and strict attention is given to commonly recommended policies of infant care and aseptic technics. Segregation and early discharge of infants are probably only adjunctive control measures which should not be adopted to the exclusion of more proved and direct measures to control the spread of infectious agents in a nursery.

Summary and Conclusions

An epidemic of nursery-derived suppurative illnesses of infants and mothers due to Staphylococcus aureus phage type 52/42B/80/81 is described. Ten per cent of all deliveries during the epidemic were complicated by disease due to the organism; one-half of the infections began after the infant was discharged from the hospital. Infant pyoderma was the most common disease noted; breast abscesses were the most common maternal infection. Most of the infections were mild, but several infant fatalities occurred.

The strain was recovered from infants, nurses, mothers, and nursery dust. The epidemic was apparently controlled by the removal of carriers from the nursery, by the application of more rigid aseptic technics, and by measures designed to prevent the spread of the organism from infant to infant.

Evidence is presented suggesting that this strain, heretofore considered a "hospital Staphylococcus," is now commonly found in the general community. The implications of this with regard to the future prevention and control of nursery infections are discussed.

The epidemiology and control of nursery-derived staphylococcal infections are discussed.

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Dr. Fekety is a member of the Epidemic Intelligence Service, Communicable Disease Center, Public Health Service, U. S. Department of Health, Education, and Welfare, Atlanta, Ga., and is assigned to the Biological Division, Department of Medicine, Johns Hopkins University School of Medicine, Baltimore, Md. Dr. Shaffer is director, Division of Laboratories, State Department of Health, Trenton, N. J. Dr. Buchbinder is assistant director and Mr. Goldberg is assistant bacteriologist, Bureau of Laboatories, New York City Health Department. Dr. Price is the pathologist and Dr. Pyle is an attending pediatrician, Valley Hospital, Ridgewood, N. J.

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EVALUATION OF THE PHONE SURVEY IN AN OUTBREAK OF STAPHYLOCOCCAL INFECTIONS IN A HOSPITAL NURSERY FOR THE NEWBORN

Walter A. Murray, Jr., M.D.; Gerald E. McDaniel, M.D., M.P.H.; and May Reed, B.S., R.N.

DURING THE fall of 1956 the physicians in a moderate-size Southern city noticed an increasing incidence of severe suppurative lesions in newborn infants and recently delivered nursing mothers. Concern was heightened when two infant deaths occurred, one the result of fulminating staphylococcal septicemia, the other of staphylococcal pneumonia. Since the infants died in different