Microbial levels in a general hospital nursery and nursery with rooming-in facilities of a maternity hospital.

MICROBIAL LEVELS IN A GENERAL HOSPITAL NURSERY AND NURSERY WITH ROOMING-IN FACILITIES OF A MATERNITY HOSPITAL

A thesis presented

by

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(Chairman of Committee)

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on my findings. This was one of the most valuable learning experiences in this study.

DEDICATION

To both of my parents who sacrificed so much to give me an education.

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INTRODUCTION

Rooming-in has been considered by many as a modern innovation to the nursery, which, as we know it, has been in existence since 1900. For some of the members of the medical profession, the standard nursery is the only method of infant care that they have experienced. However, strange as it may seem, rooming-in was in existence prior to the standard nursery (5).

Originally, the maternity hospital was utilized to care for poor, homeless women, e.g., the Boston Lying-in was established "for women during childbirth who from misfortune or otherwise had no home" and for "that class whom maternity makes outcasts" (15). These hospitals were of the "rooming-in" variety, where the infant was kept next to the mother. "Hight nurseries" were the next step in the development of what we now consider the conventional nursery. They were set up mainly because these women were either too ill or tired to care for their own babies. Also there was the problem of the one restless baby who kept the whole ward awake.

These hospitals were pest houses with diptheria, scarlet fever, and many other diseases sweeping through wards killing infants and mothers alike (20). By the 1900's, the hospital was beginning to be the place to

have babies, especially among the affluent. "Night nurseries" gradually became day nurseries in order to protect the infants from the diseases on the wards. In fact, it was believed that infections were spread from mother to child, and the less these two made contact the better (30).

The "aseptic" conventional nursery has been a standard in hospitals until 1942 when, again, there was a "modern" revision. This was rooming-in, and the cycle was now complete.

The term "rooming-in" was first used by Gesell and Ilg to suggest the potential advantages of this type of an arrangement for the baby (20). While there were many reasons for the return to the old system, it was primarily to prevent epidemics from spreading from baby to baby. It was believed that most infections were spread by persons handling the baby, and having the baby back with the mother would reduce the number of contacts the infant had with hospital personnel.

Another major reason for returning the babies to the mothers was the belief that great psychological impairment may result when the infant and mother are separated during this time. It has been demonstrated that when the mother saw less of her baby, she recovered more slowly and had much more post-partum depression than if the baby were by her side. The babies were also more content being with their mothers and they seemed to be healthier, since they received constant care.

In the modern hospital we have these two systems in existence and sometimes adjacent in the same hospital. This study was undertaken to determine if any quantitative and/or qualitative differences in the microbial population exist between the two systems. The methods used to determine the microbial population include air sampling, floor sampling, and the sampling of various foci throughout the nursery and patient rooms.

REVIEW OF THE LITERATURE

Since the conventional nursery was established, there have been many outbreaks of disease among the infants. Methods of preventing epidemics are common in the literature but, at the same time, are quite diverse and even contradictory in method. Shinefield stated that outbreaks of Staphylococcus aureus were due to (a) use of antibiotics which increases the reservoir of resistant S. aureus, (b) increase in the number of patients susceptible to infections, and (c) increase in procedures that facilitate the introduction of S. aureus into susceptible patients (54). Geidt stated that the epidemiology of S. aureus outbreaks were influenced by (a) nursery design, (b) density of infant population, and (c) obstetrical and nursery practices. He also stated the S. aureus infections were due to the many bacteria on the linen which were dispersed into the air during linen change, and that the relative concentration of large numbers of organisms in the nursery was due to crowding patients (26).

S. aureus epidemics are very hard to control. One reason is that this organism is very resistant to drying and can be carried by dust particles thereby acquiring infection through airborne transmission.

Secondly, as previously stated, there is now a reservoir of S. aureus in our hospitals that is resistant to antibiotics. Should infection set in with these organisms, antibiotic treatment will be greatly reduced in value. Thirdly, S. aureus is carried by many healthy individuals. It is mostly found in the nose and on the skin. Periodic surveillance of nursery personnel must be undertaken to prevent contact between carriers and infants. Studies have shown that S. aureus can still be carried on the hands even after handwashing (8).

Bacterial interference has been one method used to combat S. aureus epidemics. Shinefield stated that cross-infection could not be prevented by changing gowns and masks, placing antibiotics in the nose, or elimination of carriers. The only method he found effective was the deliberate colonization with a non-virulent S. aureus strain (54).

Colonization in the newborn infant first took place on the umbilicus. It only took ten bacteria to result in effective colonization at this spot in contrast to 250 bacteria needed for effective colonization of the nasal mucusa (54). Therefore, cord care should be of primary importance in the nursery, since this area is most susceptible to infection.

Shinefield stated that it was important to note that colonization does not necessarily result in infection. A S. aureus strain 80/81 colonized some infants with no

infection resulting, while a seemingly identical strain caused an infection rate of 50%. Shinefield could find no explanation for this behavior (54).

Boris was another to successfully use bacterial interference as a method of protection against S. aureus disease. He stated that the colonizing strain must (a) be benign, (b) colonize easily, (c) persist longer than the stay in the nursery, (d) be easily identified in the laboratory, and (e) be susceptible to penicillin and many other antibiotics (14). Although Boris previously tried to control epidemics by antibiotics, hexachlorophene baths, rooming-in, closing nurseries, ultraviolet light, and sterile technique, the only method he found successful was bacterial interference.

Light, Sutherland, and Schott (34) also used bacterial interference to terminate an outbreak of infection. They were quick to point out that if an infant was already colonized by a different S. aureus strain, then they would not accept the artificial colonization with a new strain. Therefore, bacterial interference could only be used to prevent colonization of infants. It could not be used to treat already infected infants.

S. aureus was not the only organism used in cases of bacterial interference. Ehrenkranz did a study with diptheroid colonization which resulted in a decrease in coliform and Proteus colonization (21).

As already stated, identification of Staphylococcus

in the laboratory is very important in epidemiological studies. Oeding developed a method of serologically typing S. aureus using eight factor sera, and obtained, when comparing serologic testing with phage typing, identical results when studying epidemiologically related strains (49). However, Cohen found that serology was more reliable than phage typing, due to the variability of the phage types (19).

Serological typing techniques have divided S. aureus into a few broad groups (49), but have not provided definitive typing necessary for tracing the spread of infection. Phage typing has been of value in distinguishing types of S. aureus which were not distinguishable by other means. Some of these phage types have been shown to be of epidemiological significance (58).

Fisk was the first to develop a system of phage typing for S. aureus. Modifications of this system using up to 23 phage types are employed today (23).

Six major S.aureus strains were shown to be responsible for epidemics between 1954-1957. They were 54/57/80/81. 52A/79, 71, 7/47/53/54/75, 47/53/75/77 and 75/77. (58).

Using phage typing techniques, S. aureus has been divided into three main groups which are differentiated by phage type patterns (58). Reports of hospital associated strains showed a predominance of group III strains (2,17) but group III were not found more frequent

from disease conditions in patients not hospitalized (25). Penicillin resistance seems to be correlated with susceptibility to group III phages irrespective of the clinical source (58). It has been shown that although many group III strains act as opportunists, some may be brought home from the hospital by a newborn infant and then cause disease in healthy family members (53).

Another method used to combat staphylococcal epidemics has been hexachlorophene baths. Hexachlorophene bathing was used effectively to reduce the presence of S. aureus. However, Light found that although the baths did reduce the Staphylococcus population, the baths also resulted in significant increases in gram negative bacilli in the nasal mucosa and umbilicus. It was also discovered that the gram negative bacilli was Pseudomonas and that a direct ecological relationship exists between these two organisms (33).

The Food and Drug Administration showed that 50 infants bathed daily with hexachlorophene preparations absorbed measurable quantities of the chemical into their blood, although none displayed toxic symptoms. In another study, a group of baby monkeys bathed with a 3 per cent solution for 90 days developed brain lesions, and in a third study, rats fed the chemical showed physical brain damage (6).

As a result of this, the Committee on Fetus and the Newborn of the American Academy of Pediatrics

recommended dry skin care, washing with plain soap and water or tap water alone for skin care of newborn infants. Hand contact was found to be the most important spread of infection. This could be minimized by scrupulous hand washings before and just after handling each infant. Either in iodophor preparation or a 3% hexachlorophene emulsion was recommended for this scrubbing (6).

When the ban on hexachlorophene bathing was first announced, the Center for Disease Control did not necessarily see any danger of a real staphylococcal outbreak in the nursery, since there were some nurseries who never used hexachlorophene, and these nurseries kept their staphylococcal infections to a minimum (7). However, within two months of the warning, confirmed outbreaks, defined as two or more concurrent cases of staphylococcal infections, were reported in 24 hospital nurseries. At the conclusion of a meeting between the C.D.C., F.D.A., and the American Academy of Pediatrics, they concluded that the potential hazards of using hexachlorophene outweighed its benefits. Officials emphasized that hexachlorophene should be used in hospitals only as a last resort to stem confirmed S. aureus outbreaks. It was also stressed that it is still recommended as a handwashing agent for hospital personnel (7).

Brachmenn of C. D. C. recommended the following procedures for controlling the existing staphylococcal outbreaks (9).

a. The use of prophylactic bathing of healthy infants with hexachlorophene followed by a tap water rinse. The bathing with hexachlorophene should be discontinued when the newborn is discharged.

b. The requirement of the nursery personnel to wash their hands with hexachlorophene or iodophor preparation before each infant contact.

c. The use of a phenolic or iodophor germicide on all nursery furniture, the autoclaving of all instruments and basins, and the laundering of all bedding before new admissions.

d. The use of a rotation or cohort system of admissions (48 hour intervals). The first nursery being emptied and cleaned before any new babies are admitted.

e. The daily culturing of umbilical stumps and anterior nares of all occupants of infected nurseries and the geographical isolation of those infants who show S. aureus colonization. All of these infants should be treated topically with appropriate antimicrobial agents.

f. The examination of all nursery personnel, including physicians, for draining body

lesions or colonization of the anterior nares. Staphylococcus carriers of the same type as found in infected infants should be excluded from the nursery until cultures are negative.

g. The surveillance of discharged infants for 14 days.

In contrast to all of the methods for controlling S. aureus epidemics so far, there have been articles such as the one in Medical World News which stated that S. aureus infections have been controlled by lessening the asceptic technique. This involved (a) no caps or masks, (b) babies'first bath delayed and then bathed in sterile water, (c) no hairnets, (d) parents permitted to enter the nursery and care for infants, (e) brushes for pHisohex discontinued, (f) gowning discontinued. Workers were not excluded from the nurseries if they were found to be carriers of S. aureus unless they subsequently developed lesions.

As a result of the above procedures it was reported that the colonization rate fell from 4.5% to 2.9%. Before these methods were activated there was a peak colonization rate of 17.7%. Infected babies during the study were cared for in incubators in a separate room by the same staff. No other precautions were taken. The conclusion of this study was that a system of surveillance and immediate remedial action was important.

Simplified technique encouraged the doctors to enter the nursery more often and consequently the infants were observed more closely (10).

There is a volume of literature that contradicts this method of surveillance. Williams reported a study of healthy carriage of S. aureus in which he definitely concluded that healthy carriage can be harmful (59). Not only does colonization in the infant occur, but the child then may infect the mother. She in turn acquires a breast abscess caused by the carrier strain (61).

Fierer found that the original source of a Pseudomonas aeruginosa epidemic was traced to the resuscitation equipment in the delivery room. However, cross-infection could not be controlled as long as the babies were treated by the same personnel. Contaminated hands were thought to be responsible for this cross-infection, and infected babies had to be removed from the nursery (22).

Adler found that Klebsiella colonization could only be controlled by frequent and effective handwashing. Brushes are an aid in handwashing and would seem to be helpful in obtaining effective results (1).

Although lax methods required of the personnel does not necessarily mean lax methods in housekeeping, there does seem to be a risk when this type of control as suggested by Medical World News is used. Housekeeping is very important in the hospital, especially in the nursery. All equipment must be scrupulously cleaned and

disinfected regularly. Caps of plastic bottles used to moisten the umbilical cords were found to be heavily contaminated with Serratia marcescences. This contamination was only discovered because the nursery developed an epidemic of Serratia (40). Contaminated incubators and resuscitation equipment have also been found to be the cause of nursery epidemics (16).

Since such care must be taken to insure that all equipment is free from contamination, it is the responsibility of housekeeping to keep the environment such as floor, sinks, wall, etc. as free of bacteria as possible. It is the nursing staff's responsibility to insure that each infant has his own set of personal utensils, such as brush, washcloth, etc. and that this equipment is free from contamination.

Many papers have been written about the elements involved in the spreading of organisms from one baby to another. Love did a study in which he concluded that the diaper was an important element in the transmission of organisms from one babysite to another. Love also found that hands were a major source of contamination, whereas air was relatively unimportant (38). However, Knight found that air hygiene was very important (31).

The methods used in this study to sample the air are discussed by Wolf with comparison among the many different air samplers (60). Bourdillon did a study using the Slit Sampler (16). This was a comprehensive paper on the value of this instrument. Shaffer also studied the

the Slit Sampler (52). All papers stressed the convenience of the Slit Sampler, and although it is not as accurate as some other air samplers (such as the Anderson), it gives a satisfactory relative study of different environments.

Housekeeping techniques for the nursery as set up by Litsky show very stringent controls. Housekeeping personnel should wear caps, gowns, masks, gloves, and shoe coverings while cleaning and disinfecting. Litsky recommends the use of quaternary ammonium compounds or chlorine releasing ones to clean furniture surfaces that are in intimate contact with skin or food. The floor should be (a) dusted by filtered vacuum machine, (b) mopped by sterile mop heads which are then discarded, (c) flooded for five minutes with detergent that doesn't interfere with conductivity, scrubbed with an effective scrubbing machine, and dirt removal with a wet vacuum pick-up machine, (d) no dry dust mop should be used, and (e) aerosol sprays should be used to decontaminate after dirty or infected cases (35).

During housekeeping procedures such as mopping and bed making, Walters found that air counts were highest. Using a wet vacuum pick-up machine and disinfectants reduced these counts significantly (57).

There is some controversy involving carpeting in the hospital, especially in critical areas such as the nursery. Litsky found that in control chamber

conditions, the air borne count over carpeted surfaces was higher than over tiled surfaces (37). However other studies such as the one in Pittman Hospital Forum have found that carpeting was preferable to tile in all areas of the hospital (11).

Housekeeping procedures are not just involved in microbe control. Amstrong reported a case of pentachlorophenol poisoning in the nursery. This was the result of a poisonous laundry neutralizer used in the hospital laundry (5). Therefore all housekeeping procedures, even those not in direct contact with the patients, must be scrutinized as to their effectiveness and as to their possible effect on the patients.

Standards for nurseries have been recommended by various agencies. Litsky gives some bacteriological standards for the nursery in her book Hospital Sanitation. She stated that during periods of inactivity a 0-5 colony counts in a ten minute exposure of a blood agar plate should be maintained. When babies are handled this count may rise to 8-10 colonies per plate. Linen change may result in counts of 15-25 colonies per ten minute exposure. Floor counts using Rodac plates should be 0-8 colonies per plate after cleaning (35).

The American Academy of Pediatrics has published a set of standards. The Academy did not list bacteriological standards for the air and floor. Some of the standards included were (a) one Registered Nurse for each twenty

babies, (b) one nursing person for each eight babies, (c) annual physical examinations including chest x-rays of all nursery personnel, (d) no more than ten babies on each side of the nursery with a nursing station in between, (e) two feet of space between each bassinet (a minimum of 24 square feet per infant) -- if this is not possible, then cubicle partitions should be used, (f) air changed twelve times an hour, (g) a minimum of 40 square feet per infant in an observation nursery, (h) masks are not recommended for regular nursing staff since it is believed that masks give a false sense of security (masks must be changed every 20 minutes to be effective) and (i) no jewelry should be worn in the nursery (4).

Finally the Academy of Pediatrics recommended that in the case of an epidemic the babies should be removed from the nursery and placed with their mothers. This was, in fact, recommending rooming-in. Rooming-in has been the topic of much discussion in the past and present. Some studies have contradicted the Academy's position on rooming-in. Frazer reported that he found the highest cross-infection rate when babies were kept with their mothers and the least cross-infection when the babies were kept entirely separated from the lying-in wards (24).

There have been many cases in the literature which support the recommendations of the American Academy of

Pediatrics. Craig, in a study reported in 1958, indicated that babies placed with their mothers full-time was a very effective method of controlling cross-infection (20).

Rooming-in programs have proven successful in many hospitals. Bloomquist reported a study of rooming-in developed at the Michael Reese Hospital in Chicago. The program proved so successful it was expanded (13). Barnett reported a successful plan of rooming-in at Los Alamons, New Mexico (12). Snoke reported a rooming-in project in which he concluded that four bed units were better than single or double bed units (55).

In planning a rooming-in program it was suggested that an "ad-lib" schedule be followed where the mothers can return the babies to the nursery if they wish (50). Stott suggests that (a) rooming-in should be permissive not compulsory, (b) an intelligent interest should be evidenced on the part of the mother, and (c) there should be an absence of any emotional or social problems (56).

Infection rates have decreased when rooming-in programs have been instituted. Seidemann reported that not one infection in 4 1/2 years has been recorded since rooming-in was established at Lebanon Hospital in New York (51). Montgomery reported that out of 4029 babies delivered since rooming-in was established, only

five were placed in isolation nurseries (45).

Montgomery stated that rooming-in was beneficial since it (a) prevented epidemics, (b) improved mother-baby relationships, (c) stimulated breast feeding, (d) improved child care and (e) educated the mother in baby care (46). Moyer reported that in addition to the above reasons, rooming-in lessened the parental tension and depressions (47).

From the administrative point of view Nusbaum reported that rooming-in was preferable since it resulted in (a) high occupancy and parental demand, (b) comparable or even lower cost than general maternity floor care, (c) initial benefits for both mother and infants, (d) participation and active support by the obstetrical staff and (e) propagation of good public relations (48).

EXPERIMENTAL PROCEDURES

Floor and air samples were taken at two hospitals. Each of the hospitals will be discussed separately.

I. Hospital A

Description of the hospital

Hospital A is a general hospital with a 330 bed capacity. The hospital has three nurseries -- two regular and one premature. The Infection Control Committee meets every other month.

Description of nursery procedures

At the time this study was undertaken, August to November 1971, pHisohex was used in the nursery for the regular bathing of infants and for scrubbing of nursery personnel. Faucets at the surgical scrub were knee operated.

The housekeeping department was responsible for all cleaning in the nursery. Cidex and Ves-phene (1/2 ounce per gallon) were used for decontamination and cleaning. Both of these are phenolic compounds. Zephrin was used on the infants' buttocks after diaper

changes. The nursery was scrubbed daily. Wet mopping was the method of scrubbing the nursery. No dry mopping was used. Mop heads were changed once a day. Mop heads were washed in a washing machine and were not autoclaved before use in the nursery. The bucket of water was changed after each room. Cleaning took place while there were some babies in the nursery, if these babies were not going to their mothers for feeding.

Nurseries were fogged only after isolation cases. The floors were stripped every three months. Wax is added to the wash water every day. The floors were waxed individually every three weeks. Floors in the nursery were buffed regularly. Floors were sealed every three months. Nursery walls were scrubbed every five days. Zephrin was used to damp wipe furniture in the nursery after each case. Bacterial surveillance included air samples taken of the nursery once a month. Trash and garbage were collected approximately five times a day.

Caps were worn by all nursery personnel. Masks were worn by all other non-regular personnel entering the nursery. Surgical gowns were worn by all who entered the nursery. Scrub dresses were worn by all nursery personnel. Nose and throat cultures were done on personnel every three months. All personnel have a yearly medical check-up. Pre-employment physical exams included Wasserman tests, chest x-rays and nose and throat cultures. Nasal Staphylococcus carriers were not

permitted to work in the nursery department until subsequent cultures are negative.

No formula was prepared in the hospital. Similac prepared formula was used.

The nurseries were air-cooled. The air in the nurseries was recirculated and filtered. All windows were protected by screens.

Description of nurseries

Each regular nursery had a ten infant capacity. Babies were admitted to the nursery depending upon the time of birth, and all babies born within 48 hour intervals were housed together. This nursery was then emptied and scrubbed down before new infants were admitted. Layouts of both regular nurseries are found in Figures 1 and 2.

Methods of Sampling

The nursery with the greatest number of babies was sampled each day.

Methods of air sampling

A high volume air sampler was used, which sampled 1000 liters per minute. Tryptycase Soy Broth (BBL) was used as the culturing substrate in the machine. This broth was collected at three milliliters per minute. Five samples were taken during each testing period. Inactive, active and cleaning periods were sampled. Active periods were defined as any periods in which

FIGURE 1

Nursery #1 at Hospital A

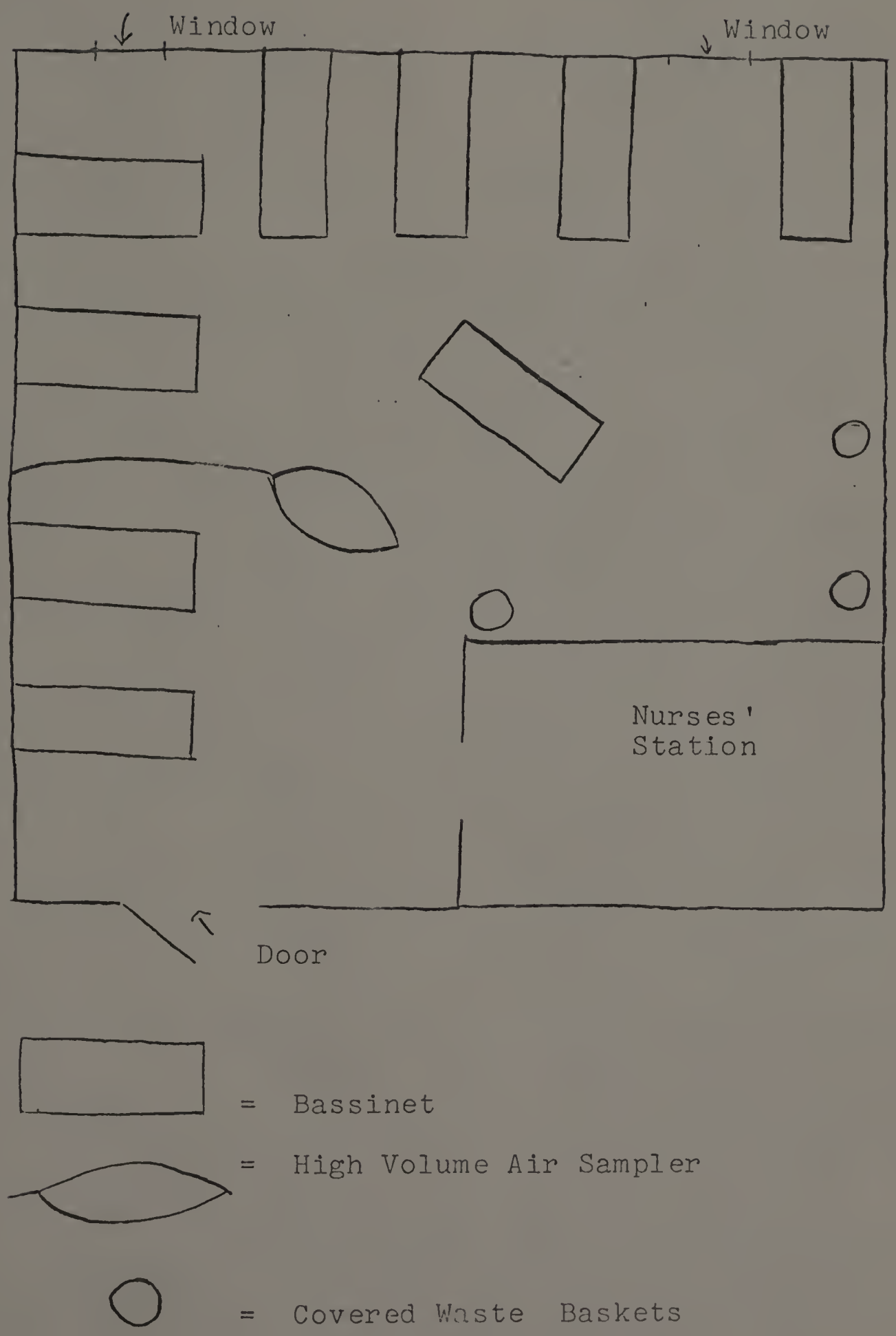
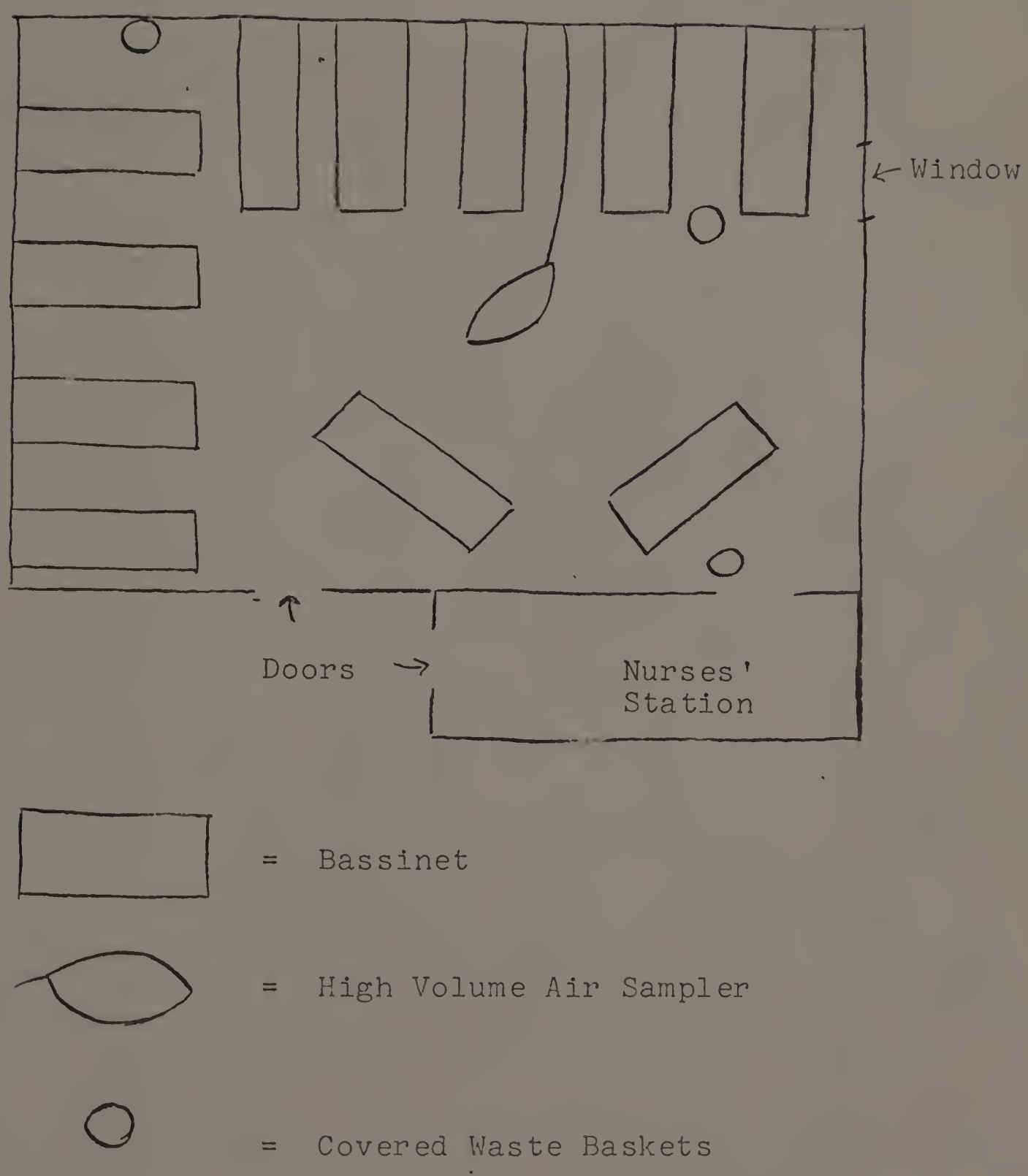


FIGURE 2

Nursery # 2 at Hospital A



handling or transporting of the infants occurred. The collecting broths were then diluted and plated employing Tryptycase Soy Agar (BBL). These plates were then incubated at 37C for 48 hours. The resulting counts were converted to organisms per cubic foot for reporting.

Results of air sampling

Air samples averaged between 4 - 29.7 organisms per cubic foot (Table 1). Mean values were determined as, 10.7, 14.5, and 15.0 organisms per cubic foot for inactive, active and cleaning periods respectively.

Methods of floor sampling

Floor counts were taken by Rodac plates containing Letheen agar (BBL). One portion of the floor was tested before and after cleaning. Ten rodac plates were used before cleaning and ten used after cleaning. After cleaning a period of ten minutes was given to allow the floor to dry before sampling.

Results of floor sampling

Table 2 shows the floor counts before and after cleaning. The percent reduction of organisms after cleaning ranged from 3.7% to 64.8%. The mean percent reduction was 55.0%.

Methods of Staphylococcus aureus isolation

On two different days *S. aureus* was isolated from broth samples collected. Broth that was collected during

TABLE 1

Results of Air Samples at Hospital A

	ORGANISMS/CUBIC FEET		
Sample Number	Inactive Periods	Active Periods	Cleaning Periods
1	22	31	26
2	23	16	12
3	4	3	9
4	6	3	9
5	5	13	22
6	4	6	10
7	11	30	17
Range	4 to 23	3 to 31	9-26
Mean	10.7	14.5	15.0

TABLE 2

Floor Counts using Rodac plates at Hospital A

	Colonies/Rodac		
	Before Cleaning	After Cleaning	% Reduction
	85	30	64.7
	54	52	3.7
	36	17	52.8
	36	15	53.3
	71	25	64.8
	38	20	47.3
	125	47	62.4
	71	41	42.2
	54.4	49.9	8.0
	55.6	21.2	61.9
Mean	62.6	31.8	55.0

cleaning was used. A sample of .5 mls was spread plated on five Tellurite Glycine Agar (Difco) plates. All Tellurite positive colonies (black pigmented) were picked and streaked onto Mannitol Salt Agar (BBL). Pigments, catalese reaction, and coagulase reaction were noted. S. aureus colonies were defined as those gram positive cocci, which were catalase and coagulase positive. No S. aureus colonies were phage typed.

Results of S. aureus isolation

Of the 38 tellurite positive colonies isolated on October 1, 20 were determined to be S. aureus (Table 3). This is a count of 2.1 S. aureus per cubic foot. On October 29 the results were only 3 S. aureus isolated. This is a count of 0.35 S. aureus per cubic foot.

II. Hospital B

Description of the hospital

Hospital B is a maternity hospital in Boston Massachusetts. It has a 144 bed capacity and is devoted to both obstetrical and gynecological problems. There are eight nurseries at the hospital, seven general and one special care nursery. The Infection Control Committee meets once a month.

Description of nursery procedures

No pHisohex was used to bathe the babies. Nurses used it to scrub before handling the babies. Faucets

TABLE 3

Isolation of *S. aureus* on October 1, 1971
at Hospital A

Tellurite Positive	Mannitol Ferm.	Pigment Prod.	Catalase Reaction	Gram Stain	Coagulase Prod.
1	-	-	+	+	-
*2	+	+	+	+	+
*3	+	+	+	+	+
*4	+	+	+	+	+
5	-	-	+	+	-
6	-	-	+	+	-
7	+	-	+	+	-
8	-	-	+	+	-
9	-	-	+	+	-
*10	+	+	+	+	+
*11	+	+	+	+	+
*12	+	+	+	+	+
13	-	-	+	+	-
14	-	-	+	+	-
*15	+	+	+	+	+
*16	+	+	+	+	+
17	-	-	+	+	+
*18	+	+	+	+	+
19	-	-	+	+	-
20	-	-	+	+	-
*21	+	+	+	+	+
22	-	-	+	+	-
*23	+	+	+	+	+
*24	+	-	+	+	+
*25	+	+	+	+	+
26	-	-	-	-	-
*27	+	+	+	+	+
*28	+	+	+	+	+
*29	+	+	+	+	+
*30	+	+	+	+	+
*31	+	+	+	+	+
*32	+	+	+	+	+
33	-	-	+	-	-
34	-	-	+	+	-
35	-	-	+	-	-
*36	+	+	+	+	+
37	-	-	+	-	-
38	-	-	+	-	-

* Determined to be *S. Aureus*

at the surgical scrub were elbow operated. No routine environmental sampling was done when this study was in progress.

The housekeeping department was responsible for all cleaning of the nurseries. This department was under the control of a corporation which hires and trains housekeeping personnel. An executive housekeeper from the corporation was in direct control of all personnel and procedures.

"SaniMaster Pro" is used to wash the floors. This is a double quaternary ammonium compound. "Glassclene Pro" is used for mirrors and glass. This is not antibacterial. "Wall Glide Pro" is used for tables and walls. This compound is a quaternary ammonium compound.

Since an in-depth study of this hospital was done comparing the rooms with mother and child with the general nursery, an in-depth comparison of cleaning methods used for the two areas is necessary.

<u>Housekeeping procedures for patients' rooms</u>

a. Pick up the trash.

b. Wash and return the ash trays.

c. High dust with a chemically treated dust mop. This involves dusting all the high vertical edges in the room.

d. Damp dust with Sanimaster and water and dust cloths.

e. Dry mop with a chemically treated dust mop. This is done with a mop on a swivel head which is moved in one direction only. The dry mop is never lifted off the floor or taken outside the room while dusting.

f. Damp wet mop with Sanimaster and water. The floor is not soaked during this procedure. The bucket water is changed after every three or four rooms. The floors are divided and one woman cleans all the rooms and toilets in her area using the same mop and bucket.

Housekeeping procedures for general nurseries

a. Damp dust with Sanimaster and water plus dust cloth.

b. Dry mop with a chemically treated dry mop.

c. Wet mop with Sanimaster plus water. A new mop is used for each nursery. The same bucket is used for all nurseries. The nurseries are done by the same man. He travels from floor to floor with the same bucket. He does not put on anything over his clothing while cleaning the nurseries.

d. The floors of the nursery are buffed regularly (Sic).

Nursery procedures cont.

No caps, gloves, or masks were worn by any personnel entering the nursery. Persons who were not on the regular nursery staff are required to put on surgical gowns before entering the general nurseries. Nursery personnel wear scrub dresses in the nursery. If the baby is with his mother, then no visitors are allowed with the exception of the father. If he is present, he must wear a surgical gown.

No routine culturing of nursery personnel was done. A regular physical exam was required of all nursery personnel, but this did not include nose and throat cultures to isolate Staphylococcus carriers. There was no method of screening or excluding Staphylococcus carriers from the hospital.

Similac prepared formula was used in the hospital. Tap water plus bacitracin was used on the babies buttocks.

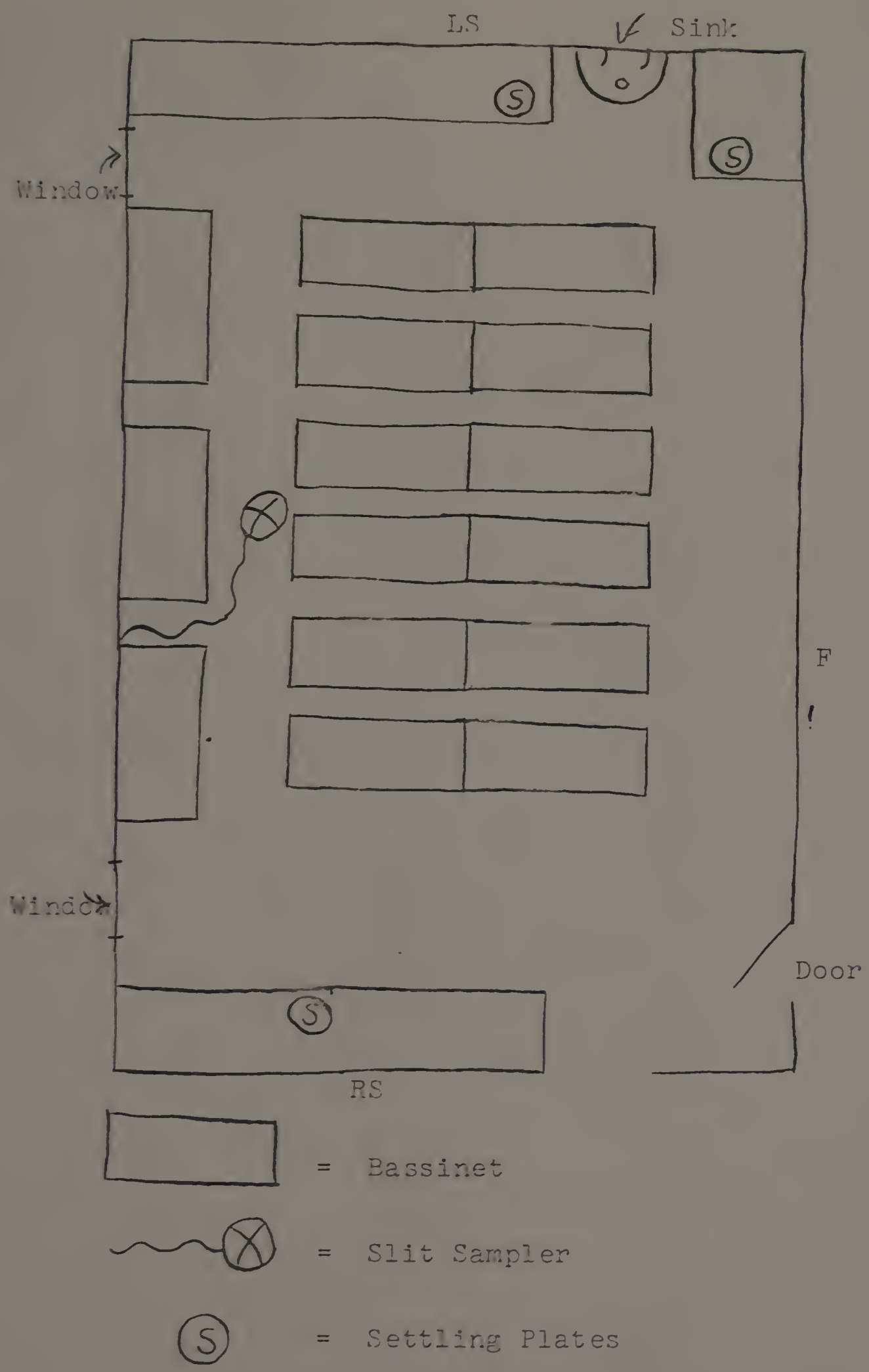
Babies are removed from the nursery during cleaning at all times. There is no waiting period after cleaning before the infants are returned to the nursery.

Description of the nursery

The nursery studied had a capacity of twenty infants. There were two identical nurseries (Figure 3) with a nurse's station in between. The nurse's station had no doors to the corridor or to the nurseries. The

FIGURE 3

General Nursery at Hospital B



nurseries each had a door to the corridor. The same nursery was sampled at all times.

Description of 'patients' rooms

Double and single rooms were sampled (Figures 4 and 5). The same room could not be tested continually due to patient inconvenience. The rooms sampled were on the same floor as the general nursery studied. Most mothers in the rooms sampled did not keep their babies with them at all times. When the babies were not with their mothers they were taken to the general nursery.

Methods of air sampling the nursery

The S/P-TDL Slit Air Sampler together with Blood Agar plates (Scott) were used in this phase of the study. The turntable was set for one revolution every twenty minutes. Plates were incubated for 48 hours at 37C. Results are reported and tabulated as colonies per cubic foot.

Blood agar settling plates were exposed for 15 minute intervals. One set of settling plates was taken for every revolution of the air sampler. Three settling plates were used each time. Plates were positioned at the same location in the nursery. Likewise, the air sampler was always in the same position (Figure 3).

The air samples were taken continuously in order to determine the effects of the various activities in the nursery on the microbial flora in the air.

FIGURE 4

Single Patient Room at Hospital B

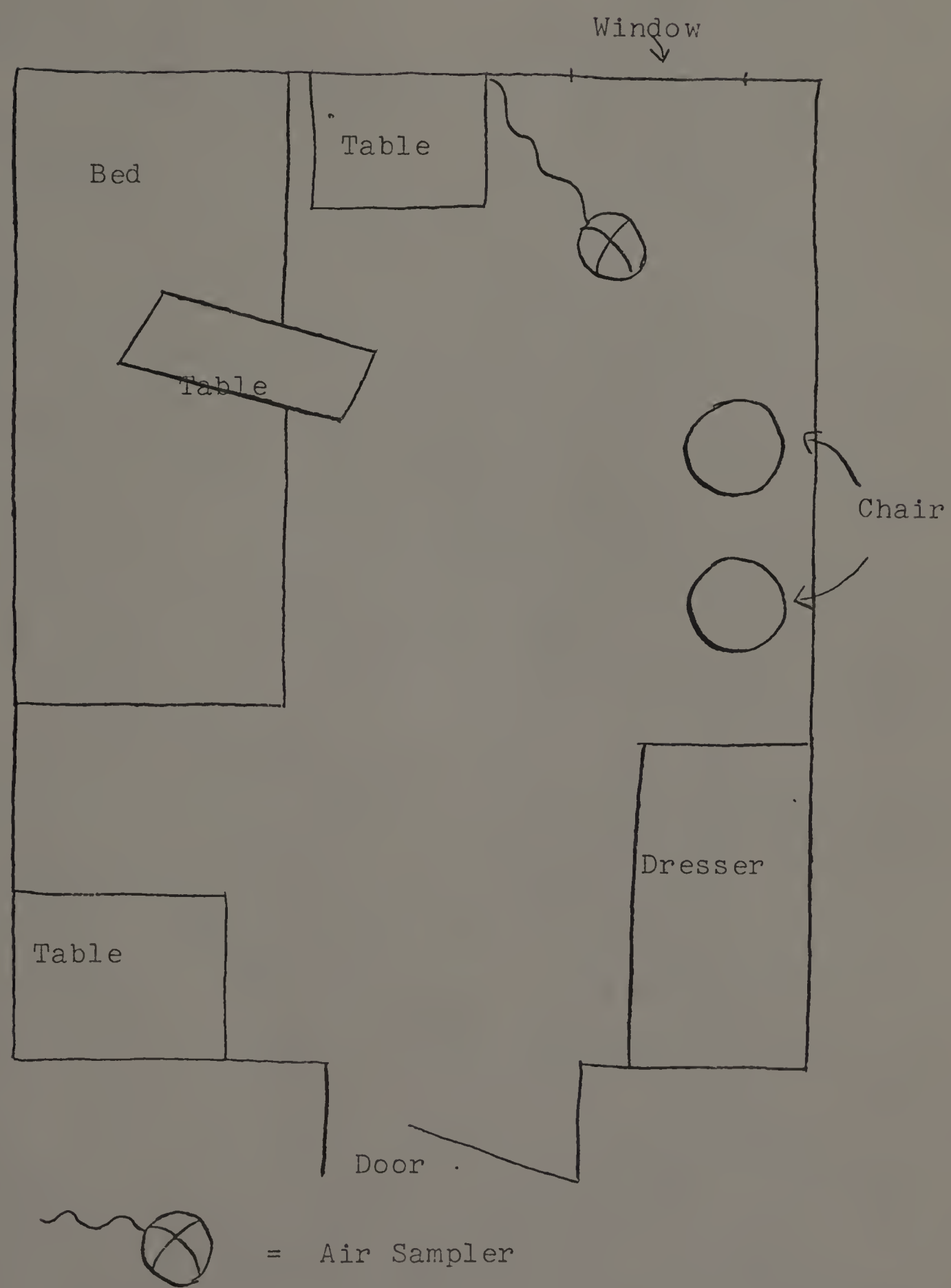
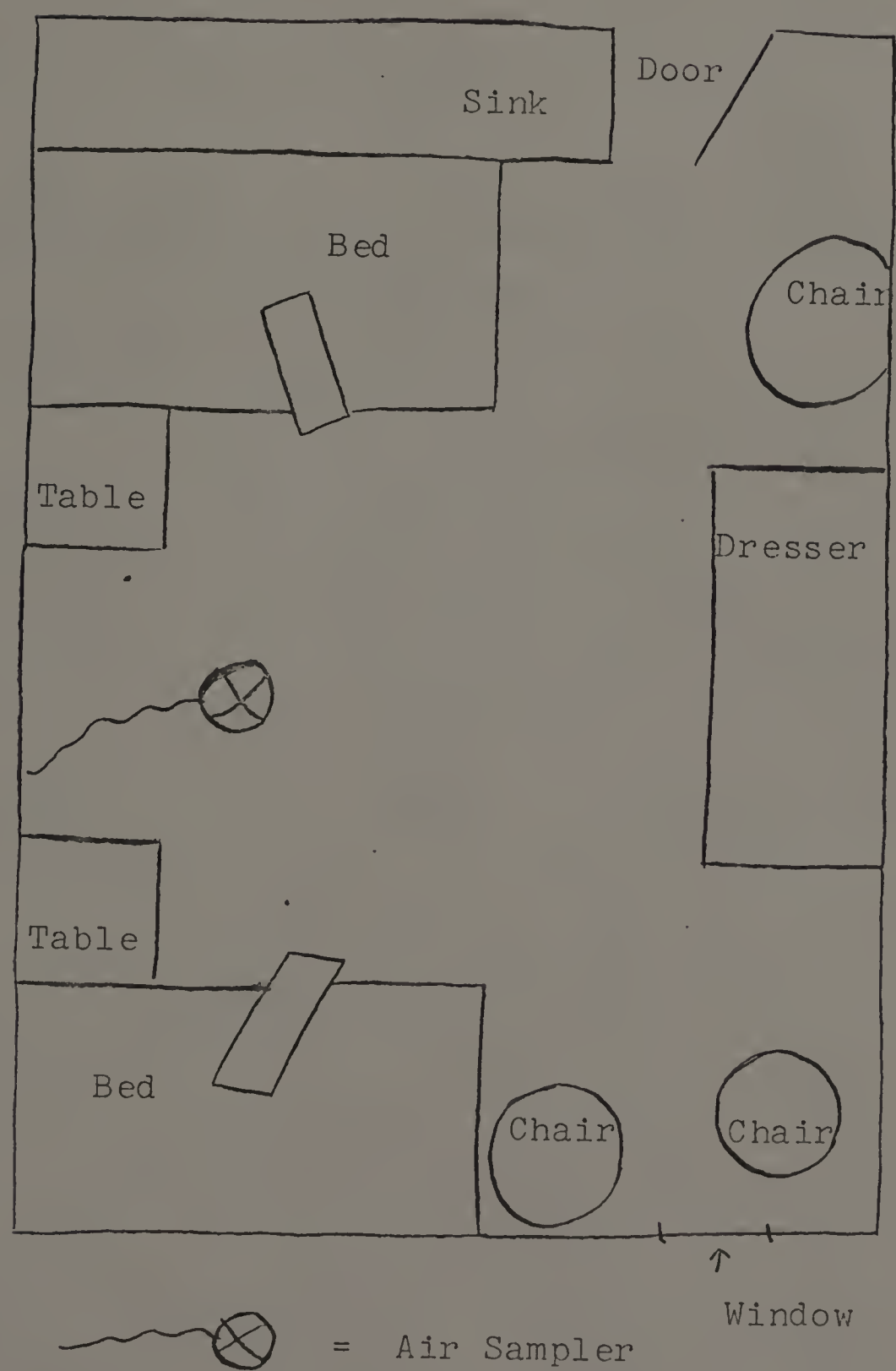


FIGURE 5

Double Patient Room at Hospital B



Results of air sampling the nursery

Table 4 shows the results of continuous sampling in the nursery. While not excessive, the highest counts occur during cleaning and bathing periods. High counts were also found when babies were being taken to and from the nursery with the nursery door leading to the corridor remaining open. Table 5 shows data from intermittent air samples and settling plates taken in the nursery. The air counts ranged from 0.4 to 4.3 colonies per cubic foot. Settling plates varied from 0 to 5 colonies per plate.

Methods of floor sampling the nursery and rooms

Floors were tested using Rodac plates before and after cleaning. After cleaning, no samples were taken for ten minutes to allow the floor to dry. Ten Rodac plates were used for each determination. A different walking area of the floor was tested each time. When the floor was buffed after cleaning, the Rodac plates were taken after buffing.

Results of floor sampling the nursery and rooms

Table 6 shows the before and after cleaning counts, as well as the percent reduction in each case. There were cases where the actual floor count increased after cleaning, which are indicated in parentheses. On the other hand the percent reduction rose as high as

TABLE 4

Results of Continuous Air Sampling in Hospital B Nursery

Sample Number	Activity	Air Sampler (colonies/cubic foot)	Settling Plates LS (colonies/15 min. exposure)	RS	F
1.	None	1.25	0	1	1
2.	Babies Bathed	2.85	2	3	2
3.	Babies Bathed	2.0	2	5	0
4.	Babies Transported	2.35	4	5	1
5.	Babies Transported	2.05	2	2	1
6.	Cleaning	2.35	0	2	1
7.	Cleaning	4.3	4	4	2
8.	Babies Transported	2.6	1	1	2
9.	Babies Transported	2.65	2	1	0
10.	None	1.15	1	2	1
11.	None	1.45	1	3	2
12.	None	0.7	1	0	2
13.	None	0.8	0	0	0

TABLE 5

Air Samples of the General Nursery
at Hospital B

Air Sampler	Settling Plates		
	LS	RS	F
(colonies/cubic foot)	(colonies/15 min. exposure)		
1.6	4	2	3
2.15	4	3	4
1.9	2	0	5
1.05	3	1	5
0.5	0	2	0
0.4	0	1	1
0.75	1	1	1
1.55	3	3	1
1.25	0	1	1
2.85	2	3	2
2.0	2	5	0
2.35	4	5	1
2.05	2	2	1
2.35	0	2	1
4.3	4	4	2
2.6	1	1	2
2.65	2	1	0
1.15	1	2	1
1.45	1	3	2
0.8	0	0	0
0.7	1	0	2

TABLE 6

Rodacs of Floor Before and After Cleaning at Hospital B

Before Cleaning (colonies/Rodac)	After Cleaning (colonies/Rodac)	% Reduction or Increase
25.5	6.95	72.75
63.8	21.0	67.08
96.0	45.0	53.12
39.6	173.3	(338)*
58.0	4.75	91.81
37.5	76.3	(103)*
43.5	0.8	98.16
50.0	22.0	56.00
42.6	13.2	69.02
29.0	30.0	(3)*
24.0	34.6	(44)*
28.4	86.0	(299)*
20.0	TNC	(1900)*
91.2	53.4	41.45
51.5	37.4	27.38
23.5	8.7	62.98
134.3	14.8	88.98
229.0	34.0	85.15
52.8	44.9	14.96

* ( ) = % increase

98.16% on other days.

Methods of sampling nursery sinks

Tap water was tested by placing a drop of water directly on a blood agar plate. A sterile swab was used to swab the drains in both the nurses' station sink and the nursery sink. The swab was then rolled over a blood agar plate. Rodac plates were also taken of the drains. All plates were incubated for 48 hours at 37C. The resulting colonies were then transferred to E M B Agar (BBL) and, if needed, to Pseudocil Agar (BBL) and other fermentation media needed to make identification.

Results of sampling nursery sinks

No colonies were ever found from testing the tap water directly. Swabs used in the nurses' station drain yielded a majority of *Pseudomonas*-like organisms. The nursery sink yielded a mixed growth of *Escherichia coli* and *Pseudomonas*. Rodacs of the nurses' station sink averaged 30 colonies per plate of *Pseudomonas*. The nursery sink Rodacs averaged 260 *E. coli* and 50 *Pseudomonas*.

Methods of sampling the rooms

Patients' rooms were sampled in accordance with patient and staff permission. Both double and single rooms were sampled. Rooms were always sampled in the morning before visiting hours.

Methods of air sampling the rooms

The air sampling procedures were the same as employed in the general nursery. The S/P-TDL air sampler was put in the same relative position as in Figures 4 and 5, depending upon the size of the room and available space. Since available space was limited, only two settling plates were exposed at the most convenient areas of the room. Blood Plates (Scott) were used, and the plates were incubated, read and reported as previously stated.

Results of air sampling the rooms

The air sampler counts ranged from 1.85 to 7.85 colonies per cubic foot. Settling plates ranged from 0 to 26 colonies per 15 minute exposure (Table 7).

Methods of Staphylococcus isolation

Suspected colonies of *S. aureus* were picked from air sampler and settling plates. They were transferred to Mannitol Salt Agar (Difco) and resulting positive cultures were then streaked to Chapman Stone Agar (Difco). Those strains that were yellow pigmented, mannitol positive, catalase positive and coagulase positive were then phage typed. All strains that were phage typed were also tested for Penicillin sensitivity.

Results of *S. aureus* Isolation

A total of nine *S. aureus* were phage typed from

TABLE 7

Air Samples of Patient Rooms at Hospital B

Air Sampler (colonies/cubic foot)	Settling Plates Plate # 1 (colonies/15 min. exposure)	Settling Plates Plate # 2 (colonies/15 min. exposure)
7.4	10	11
3.05	1	3
4.55	3	6
5.1	6	8
3.6	1	2
6.2	26	8
4.45	7	5
7.85	9	15
7.45	25	9
5.8	3	6
5.85	11	12
3.0	3	2
7.15	8	2
7.55	10	4
4.2	5	1
1.85	0	5
2.3	0	1
2.25	2	2
2.4	3	5
2.15	1	4
2.15	2	3
2.6	3	1
4.15	5	16
2.1	5	4

the general nursery air and 14 S. aureus were isolated and phage typed from the patient's rooms.

Methods of phage typing

Phage typing was done through the courtesy of Dr. Ruth Kundsin's Surgical Bacteriology Laboratory at the Peter Bent Brigham Hospital.

Results of phage typing

Tables 8 and 9 show the resulting phage types of all the S. aureus isolated. Most phage types isolated from the nursery were Group III-II combination with one Group I. There were some non-typable isolated from the patients' rooms. Most the phage types isolated from the patient rooms were of Group III variety with one miscellaneous group (187).

Methods of Penicillin testing

Five milliliters of Trypticase Soy broth were inoculated with the test strain and grown 5-6 hours at 37C. After incubation, 0.1 mls were spread plated on blood agar plates. A sterile penicillin disk was placed in the center of the plate. Plates were then incubated for 48 hours at 37 C. Penicillin sensitivity was recorded when a discernible clear ring appeared around the penicillin disk.

Results of Penicillin testing

Only one strain isolated in the nursery proved not to be penicillin sensitive. It was the Group I 52± / 82±.

TABLE 8

S. aureus strains isolated from general nursery at Hospital B

Strain Number	Phage Type
1	3C
2	$3C^{\pm}$
3	$83A^{\pm}$ / 3A/ $3C^{+}$/ 71^{+}
4	$71^{\pm}$
5	83A/ $71^{\pm}$
6	3A
7	$83A^{\pm}$/ 3A
8	$83A^{\pm}$/ 3A
9	$52^{\pm}$/ $82^{\pm}$

TABLE 9

S. aureus strains isolated from patient rooms at Hospital B

Strain Number	Phage Type	Penicillin Sensitivity
1	NT (non-typable)	+
2	83±/ 53±/ 54±/ 77±	+
3	NT	+
4	187+	+
5	83A±/ 85±/ UC18±	-
6	79±/ 83A±/ 85±/ UC18±	-
7	79/ 83A/ 86±/ 53±	+
8	NT	+
9	NT	+
10	NT	+
11	NT	+
12	29±/ 79±/ 83A/ 6/ 85/ 47/53/ 54/ 84/ 77/ 83B/ UC18±	-
13	29±/ 83A/ 6/ 85/ 47/ 53/54/ 84/ 77/ 83B/ UC18±	-
14	29±/ 83A/ 6/ 85/ 47/ 53/ 54/ 84/ 77/ 83B/ UC18±	-

Of the strains isolated from the patient rooms, Table 9 shows the results. Those strains containing the UC 18 all proved not to be sensitive to penicillin.

DISCUSSION

Hospital A's Procedures

Hospital A's procedures stressed the importance of aseptic technique. This investigator had to scrub down, put on scrub dress, mask, cap and shoe coverings before entering the nursery. However, she was not required to change the face mask every twenty minutes of constant use. This would seem to be a correctable oversight. If the standards of the nursery are such that masks are required of all extra nursery personnel then proper care must be taken to assure that all such personnel use masks correctly. After twenty minutues of continuous use, the face masks become saturated with bacteria, and this condition results in shedding of bacteria to the environment, making the mask completely useless (10). Also, how the mask is worn is important. It should cover both the nose and mouth. On more than one occasion, personnel wearing masks were doing so incorrectly.

As seen in Table 1, air counts rose during cleaning at the Hospital A. Babies being left in the nursery at this time would seem to be a risk that need not be taken. The only infants that remained during cleaning were those infants not going out to be fed. This was a

small number and could be removed to the nurses' station during cleaning.

Air Counts

No direct comparison can be made between the air counts reported for Hospital A and those reported for Hospital B. This is due to the fact that two different air samplers were used. The High Volume Air Sampler was used at Hospital A and the Slit Sampler was used at Hospital B. The reason that a transition was made from the High Volume Air Sampler to the Slit Sampler was the unsatisfactory performance of the High Volume sampler. This sampler was very unreliable since it got contaminated so often. It was much too heavy an instrument to transport, since two people were needed to lift it. Although it would have been nice if there could have been a comparison between the general hospital's nursery and the maternity hospital's nursery, that was not the object of this study. It was found much easier, by this investigator to use the better air sampler (the Slit) at Hospital B and forgo the comparison between these two nurseries.

The High Volume Sampler collects air with such force that counts are reported as organisms per cubic foot. The S/P-TDL Slit Air Sampler used at Hospital B, however, does not have as much force and colonies are not broken up when sampled. Therefore, counts on the slit sampler are reported as colonies per cubic foot. Whether the higher counts reported at Hospital A are due

to the dispersal of individual colonies cannot be definitely stated. However, this must be taken into consideration when looking at the data, and, therefore, the two sets of data cannot be compared.

Both Hospital A and Hospital B had the highest air counts in the nursery during cleaning (Table 10). This increase in air count might be due to the method used in cleaning. Dry dusting could be responsible for the increase in air borne bacteria during cleaning at Hospital B.

At Hospital B the air counts were higher in the rooms compared with those in the nursery (Table 11). The mean air count in the nursery was 1.73, while the mean air count in the patient rooms was 4.38. Reasons why the counts would be higher in the patient rooms might be:

a. Older floors with deeply worn tiles. Litsky states that this might be responsible for many high floor counts (36). Bacteria and dust could be trapped beneath the floor surface. Since the floor is not flooded during cleaning, the damp mop would not allow the germicide to reach into the crevices and effectively kill the organisms there. This reservoir might be a major contributor to higher air counts in the rooms. As Table 12 shows, the floor count increases as the air counts increase.

b. As shown in Table 13, very high counts resulted during linen change. The volume of linen changed in a

TABLE 10

Increase in Air Counts During Cleaning at Hospital A and Hospital B

Hospital	Inactive Period	Cleaning Period
Hospital A	10.7 (org/cu.ft.)	15.0 (org/cu.ft.)
Hospital B	1.07 (Col/cu.ft.)	3.32 (Col/cu.ft.)

TABLE 11

Comparison between Nursery and Room
Air Counts at Hospital B

Nursery (colonies/cubic foot)	Room (colonies/cubic foot)
1.6	7.5
2.15	3.05
1.9	4.5
1.05	5.1
0.5	3.6
0.4	6.2
0.75	4.45
1.55	7.85
1.25	7.45
2.85	5.8
2.0	5.85
2.35	3.0
2.05	7.15
2.35	7.55
4.3	4.2
2.6	1.85
2.65	2.3
1.15	2.25
1.45	2.4
0.7	2.15
0.8	2.15
	2.6
	4.15
	2.1
Mean 1.73	Mean 4.38

TABLE 12

Average floor Counts and Air Counts in Patient Rooms at Hospital B

Floor counts (col/Rodac)	Air Counts (col/cu. ft.)	Settling Plates (Col/ 15 exposure)
134.3	4.9	6.1
229.0	6.1	7.8
52.8	2.4	3.4

TABLE 13

Per cent Increase in Air Counts During Linen Change and Cleaning at Hospital B

Inactive (colonies/cu. ft.)	Linen Change (colonies/cu. ft.)	Cleaning (col/cu. ft.)
61	148 (143%)*	98 (60.6%)
60	149 (147%)	117 (95%)
37	83 (124%)	52 (40.5%)

* ( ) = % increase from inactive period to linen change in cleaning period.

patient's room is greater than an infant's linen in the nursery. Since bacteria attached to the linen is shed into the air during changing, bacteria must also be shed into the air every time the patient moves. Babies in the nursery do not have as much linen to move, nor the capacity to move it in their cribs.

c. The air is not filtered and then recirculated in the patient rooms as it is in the nursery. The doors to the corridors are always open in the patient rooms. The nursery showed correspondingly higher air counts when the door leading to the corridor was left open (Table 14).

d. Personnel who work in the patient rooms do not use the same aseptic technique as in the nursery. They do not scrub before entering each room, nor do they wear scrub dresses. It is reasonable to assume that a greater reservoir of bacteria are being brought into the rooms on clothes and personnel. Plus, if the baby is not present, visitors are allowed to be dressed in street clothes.

At Hospital B both settling plates and air sampler were used together. Although quantitative data is not obtained from settling plates, qualitative data is obtainable. As Table 15 and Figure 6 show, there is a good correlation between air counts taken with the air sampler and average counts of the settling plates in the nursery. Table 16 and Figure 7 show the same data for patient rooms. On a qualitative basis, the settling plates do show corresponding increases when

TABLE 14

Air Counts in the General Nursery
at Hospital B

Door opened (colonies/cu. ft.)	Closed door (colonies/cu. ft.)
1.6	1.05
2.15	0.5
1.9	0.4
2.35	0.75
2.05	1.55
2.35	1.25
4.3	2.85
2.6	2.0
2.65	1.15
	1.45
	0.7
	0.8
Mean 2.44	Mean 1.20

TABLE 15

Air Sampler Air Counts and Average Settling Plate Counts in the general nursery at Hospital B

Air Sampler (colonies/cubic foot)	Settling Plates (colonies/15 min. ex.)
1.25	0.66
2.85	2.3
2.0	2.3
2.35	3.3
2.05	1.66
2.35	1.0
4.3	3.3
2.6	1.3
2.65	1.0
1.15	1.3
1.45	2.0
0.7	1.0
0.8	0.0
Mean 2.04	1.62

FIGURE 6 -- Air Sampler Counts and Average Settling Plate Counts in General Nursery at Hospital B

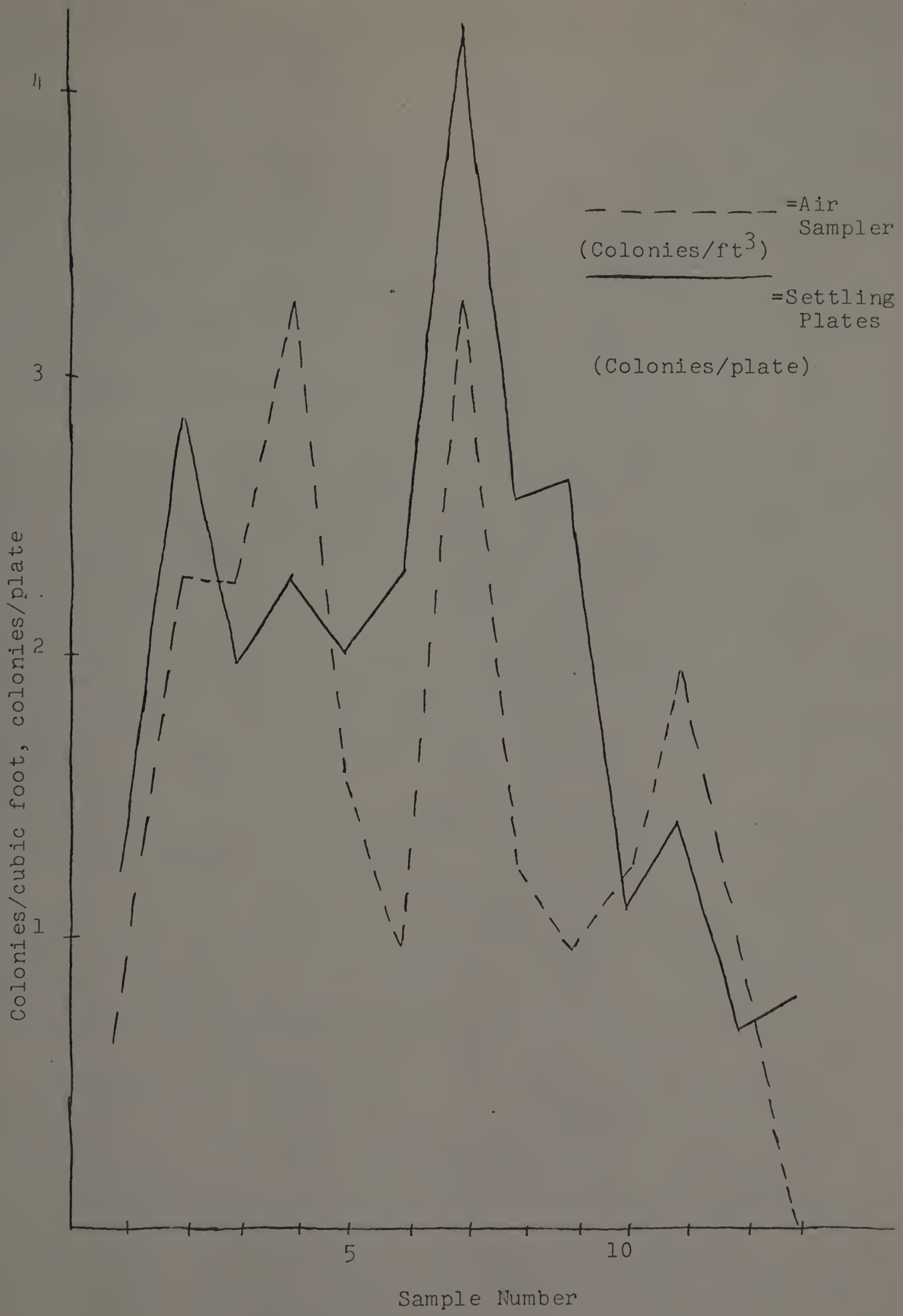


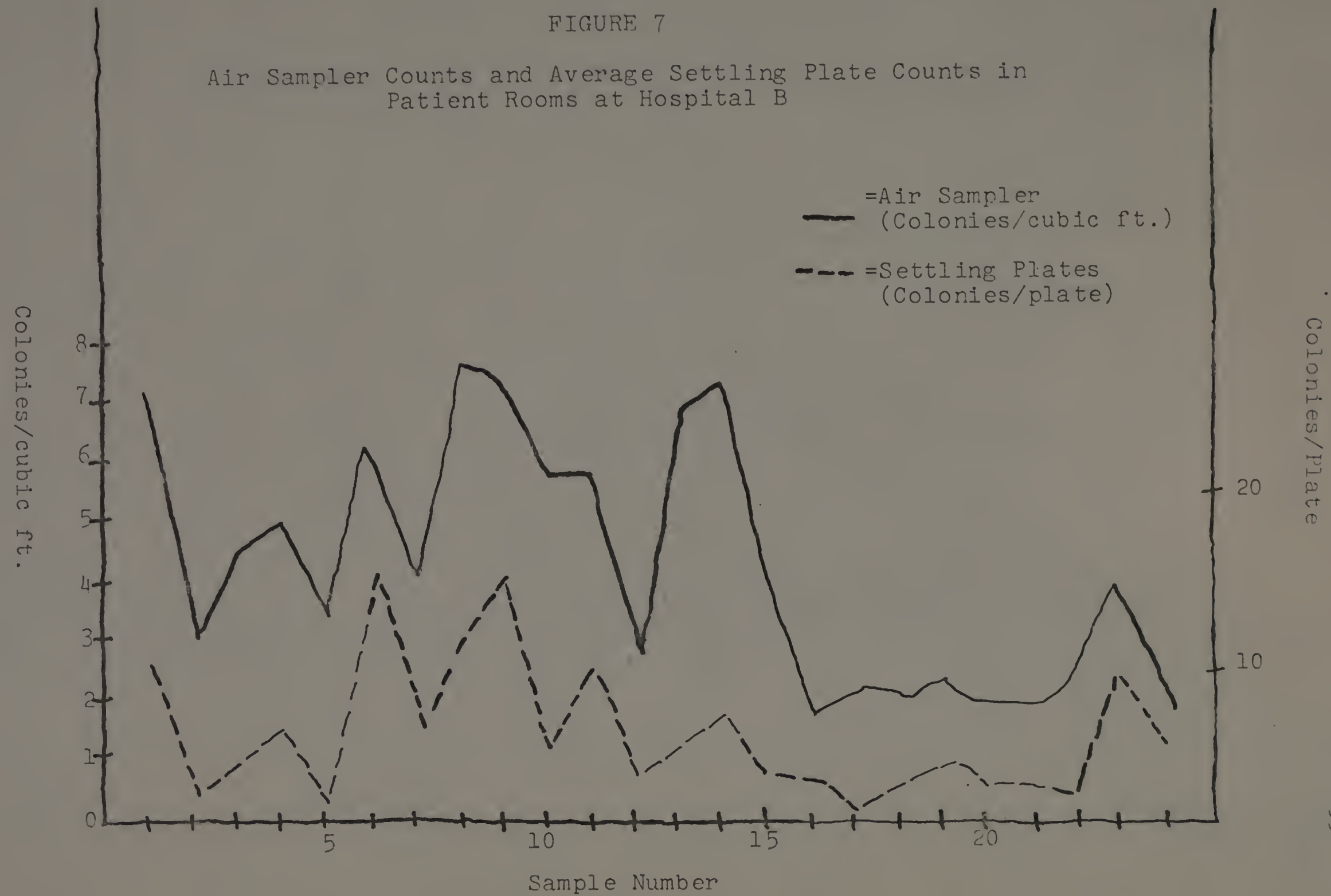
TABLE 16

Air Sampler Air Counts and Average Settling Plate Counts in the Patient Rooms at Hospital B

Air Sampler (colonies/cubic foot)	Settling Plates (colonies/ 15 min. ex.)
7.4	10.5
3.05	2.0
4.5	4.5
5.1	7.0
3.6	1.5
6.2	17.0
4.45	6.0
7.85	12.0
7.45	17.0
5.8	4.5
5.85	11.5
3.0	2.5
7.15	5.0
7.55	7.0
4.2	3.0
1.85	2.5
2.3	0.5
2.25	2.0
2.4	4.0
2.15	2.5
2.15	2.5
2.6	2.0
4.15	10.5
2.1	4.5

FIGURE 7

Air Sampler Counts and Average Settling Plate Counts in Patient Rooms at Hospital B



the air count increases and, likewise, a decrease when the air count decreases.

Settling plates are of no quantitative value since the area being tested is very small. A very localized activity next to one settling plate will show an increase in bacteria that is not representative of the room in general. The placing of settling plates throughout the room will give a qualitative representation of the air counts showing overall increases and decreases in bacteria over different periods of time.

It must also be pointed out at this time that the S/P-TDL Slit sampler is very small and the amount of air sampled is much less than the High Volume sampler. When using the slit sampler the investigator not only is getting a count of colonies per cubic foot, but also a somewhat more localized sample of the room. Activity near the slit sampler will show up to a greater degree than activity removed from the sampler. However, the convenience in handling, utilization, and noise production makes this a favorable air sampler for most hospital studies. The High Volume sampler is very heavy and requires two people to handle it. It also is a very delicate instrument which needs constant adjustment. Therefore, the slit sampler was found to be the best machine for this study.

Floor counts

Floor counts at Hospital A and Hospital B were both taken using the same methods and media. Table 17 shows the percent reduction of both hospitals after cleaning. Hospital A had a mean percent reduction of 51.8% and Hospital B had a mean percent reduction of 63.8%. However, cases where there was an actual increase in organisms after cleaning were not averaged into this figure.

At Hospital A there were two days when there was no hot water available from the tap to wash the floors. On these two days the percent reduction was 3.7% and 8.27% respectively. It seems to show that cold water lessens the effectiveness of the germicide.

Table 18 shows the Rodac counts of the floor before and after cleaning at Hospital B. These were the instances when there was an increase in bacteria after cleaning. In cases 1 and 2 there was a Pseudomonas contamination present. This could be the result of using a day old mop which happened in Case 4. The housekeeper put the mop used to clean the nursery in a plastic bag and used this mop to wash the floor again the next day. Case 3 was before and after Rodacs of an area of the floor where dirty adhesive bandages had fallen and nobody picked them up. Since they were stuck to the floor, the housekeeper had to scrub the area with an abrasive cleaner to remove all the material. As shown

TABLE 17

Comparison between Per Cent Reduction in Floor Counts after Cleaning at Hospitals A and B

% Reduction * Hospital A	% Reduction * Hospital B
64.71	72.75
3.7	67.08
52.78	53.12
58.33	91.81
64.79	98.16
47.37	56.00
62.11	69.02
42.25	41.45
8.27	27.38
61.87	62.98
	88.98
	85.15
	14.96
Mean 51.8	Mean 63.8

* % Reductions as Taken from Tables 2 and 6.

TABLE 18

Bacterial contamination after cleaning at Hospital B

Case Number	Before Cleaning (col/Rodac)	After Cleaning (col/Rodac)
1.	39.6	173.3
2.	37.5	76.3
3.	29.0	30.0
4.	24.0	34.6
5.	28.4	86.0
6.	20.0	TNC

by the bacterial counts, there was a problem created by leaving these bandages on the floor for the housekeeping personnel to remove. If they were picked up immediately, the adhesive material might not have adhered to the floor and the situation could have been avoided.

Cases 5 and 6 represent a housekeeping personnel who did not follow the directives of the contracted cleaning corporation. This individual was responsible for cleaning a number of nurseries. He was supposed to change his mop after each nursery as well as change the bucket water. He did not do so. He used the same bucket of water and mop to do all the nurseries and, as shown by the counts, was actually contaminating the nursery in the process. After housekeeping supervisors became aware of the situation, a surveillance program for all personnel was put into action. It was found that many of the personnel were not using the correct amount of Sanimaster in their cleaning water, nor were they changing their buckets as often as they should. Some housekeeping personnel were using the same mop day after day without having it washed and dried by the hospital laundry.

When the individual responsible for cleaning the nursery was followed and given the procedure used by the contract cleaning corporation, the percent reduction rose to 62.98% on the next day. Trying to impress upon housekeeping personnel the importance of their jobs is very important. Unless each individual

takes pride in his or her job and realizes its importance to the whole hospital, the danger of taking a short cut in the procedure will always be present, and thus, is a danger to the rest of the hospital.

The floor counts of both Hospital A and Hospital B were high after cleaning. An examination of cleaning methods is necessary to find how they may be improved.

Nursery sinks

The results of sampling the nursery sinks at Hospital B indicates fecal contamination in the nursery sink. The presence of *E. coli* could be due to feces on the nursery personnels' hands after changing the infants' diapers. This would then be washed into the sink when the hands are scrubbed. Diapers were never observed being placed in the sink.

Neither of the housekeeping personnel observed ever cleaned the sinks. When asked whose job it was, it was reported to be housekeeping's responsibility. However, the researcher never observed anyone ever cleaning the sink in the nursery. Sinks should be cleaned with an effective germicide, since hexachlorophene does not inhibit the growth of gram negative organisms. Cleaning the sinks by only using hexachlorophene, also allows the gram negatives like *Pseudomonas* and *E. coli* to grow in abundance.

Staphylococcus isolation

S. aureus isolation at Hospital A was done on two occasions. When this study was done no facilities for phage typing were available. On the first day, which yielded 2.1 S. aureus per cubic foot, the air filtration system was being fixed. This could explain the high counts during this week. On the next occasion that S. aureus was isolated the counts went down to 0.35 S. aureus per cubic foot. The air filtration system might be harboring Staphylococcus organisms. Shaffer and McDade (52) found that air filtration systems may harbor S. aureus. If great care is not used when fixing these systems, dust containing these organisms will be pushed back into the environment.

All S. aureus strains isolated from Hospital B were phage typed and tested for Penicillin sensitivity. It was noted that most strains isolated from the environment were phage typable. This is somewhat unusual, since environmental strains are usually very hard to phage type. All of the strains isolated from the general nursery were phage typable. This could be due to these S. aureus being shed from the babies and not environmental strains. When isolating S. aureus from patient rooms there were 43% untypable strains. This could be explained in that there is a greater reservoir of organisms in the patient rooms, therefore, the chance of picking up

resistant environmental strains is more possible.

Phage type UC 18 is a "hospital phage" and is indicative of the organisms being shed by a hospital personnel (32). This phage type only occurred in the patient rooms, so this individual must not be a regular nursery personnel.

Only one strain of S. aureus from the nursery, the Group I isolate, was Penicillin insensitive. Five of the isolated strains isolated from the patient rooms were penicillin insensitive. If these are "hospital strains", it would be expected that these strains would be more insensitive to antibiotics. More works must be done to see if these UC 18 phage types can be traced to a particular hospital personnel.

Conclusion

It was found that rooming-in at Hospital B has little or no advantage to the general nursery, from a bacteriological standpoint. Most infants are brought back to the general nursery from time to time, and they are thus handled by the nursery personnel. The patient rooms do not have the advantages of air filtration systems and air conditioning which seem to keep the environment cleaner. Also, the condition of the floor is much more worn than the nursery floors, and this contributes to a higher air count. The way the rooming-in system is set up at Hospital B, the infant might have emotional advantages in this system,

but he is bacteriologically better off in the general nursery.

The most important aspect of housekeeping procedure that this paper points out is the need for bacteriological surveillance in the hospital. Whether this is done by housekeeping, the Infection Control Committee, or the bacteriology department, there must be a system established.

If there is no system, then housekeeping has no way of knowing if their personnel are doing a conscientious job. Spot checks of the critical areas of the hospital will show if housekeeping procedures are being followed or, in fact, if the housekeeping procedures themselves are adequate. A potentially hazardous situation can develop and no one would know of its presence until an infection or, even worse, epidemic breaks out. The hospital must not wait until it is too late.

SUMMARY

Air counts and floor counts of nurseries were taken at Hospital A and Hospital B. Staphylococcus aureus was isolated from both hospitals, and those strains isolated from Hospital B were phage typed. Sinks and patient rooms were also examined at Hospital B.

The results were as follows:

a. Highest air counts in the nurseries at both hospitals were found during cleaning periods.

b. Highest air counts in the patient rooms were found during linen change.

c. Air and floor counts were higher in patient rooms than in the general nursery at Hospital B.

d. Sinks were found to be contaminated with Escherichia coli and Pseudomonas in the nursery.

e. Cleaning of the air filtration system at Hospital A led to an increase in S. aureus in the air count.

f. Using old mops can result in Pseudomonas contamination.

g. Failure to change wash bucket water and mops often during cleaning can result in contamination.

h. Doors open to hospital corridors can result in higher air counts in the nursery.

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