SENSITIVITY OF *STAPHYLOCOCCUS AUREUS* AND *ESCHERICHIA COLI* TO ANTIBIOTICS. VI

Difference of sensitivity of isolates from various clinical specimens

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In the preceding paper[1], we reported an ideal method to determine the values of minimal inhibitory concentration (MIC) of antibiotics in *Staphylococcus aureus* and *Escherichia coli* isolated from clinical specimens for grouping of the isolates into sensitive and resistant strains.

In this paper, we applied this method to isolates from various clinical specimens and the difference in sensitivity of the isolates due to difference in the source of the isolates was studied.

Materials and Method

Strains

Strains isolated from various clinical specimens during 1969 and 1971 were used. In 1970, strains of *S. aureus* were isolated from pus only.

Test for MIC of drugs

MIC of drugs in isolates was determined as described previously[2].

Method of analysis

S. aureus isolated from pus, sputum and pharyngeal mucus, and *E. coli* isolated from urine and bile were analyzed according to the following items;

1) source of isolates.
2) isolates from out- and in-patients.
3) isolates from source of infections.
4) isolates from districts.
5) size of hospitals.

Results

(1) Strains of *Staphylococcus* and *E. coli* used in this study were isolated from various clinical specimens during 1969~1971 as shown in Table 1.

Table 1. Specimens and number of bacteria.

S. aureus (1969~1971)

Specimens	Pus	Pharyngeal mucus	Sputum
Number of strains	908	120	65

E. coli (1969~1971)

Specimens	Urine	Others		
		Pus	Bile	Others
Number of strains	1,154	145	36	173

The distribution of MIC values of various antibiotics in *S. aureus* and *E. coli* grouped according to the source of the isolated strains is shown in Tables 2~8. The MIC values for grouping the isolates into sensitive and resistant strains were determined and the numbers of sensitive strains were calculated. The percentage of sensitive strains isolated from various clinical sources is summarized in Tables 9 and 11, and the test of significance of the values listed in Tables 9 and 11 is shown in Tables 10 and 12, respectively. These results show that the sensitivity of the isolates to antibiotics differs according to the source of isolates. For example, the percentage of strains of *S. aureus* sensitive to sulfamethoxazole (SMX) isolated from sputum was higher than that in isolates from pus. On the other hand, the number of strains of *S. aureus* sensitive to gentamicin (GM) isolated from sputum and pharyngeal mucus was less than that from other specimens.

In *E. coli*, the percentage of sensitive strains isolated from urine was less than that in strains isolated from other specimens. This tendency was evident especially in sensitivity to chloramphenicol (CP), tetracycline (TC), streptomycin (SM) and SMX. In isolates from bile, on the other hand, there was a high percentage of sensitive strains than in isolates from other specimens.

(2) Distribution of sensitivity of isolates from out-patients and those from in-patients was studied. The percentage of sensitive strains

Table 2. *S. aureus* isolated from pus specimens.

MIC μg/ml	PC-G	SM	CP	TC	EM	KM	SMX	CET	CER	ABPC	GM*	MIPC*	CEG*	CEX*	CEZ*
	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
0.0125	1.7	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.8	0.0	0.0	0.0	0.0	0.0	0.0
0.025	1.7	0.1	0.1	0.0	0.0	0·0	0.1	0.2	0.8	0.0	0.0	0.0	0.0	0.0	0.0
0.05	11.8	0.1	0.1	0.0	0.1	0.0	0.1	0.3	18.0	0.7	0.0	0.0	0.0	0.0	0.0
0.1	18.6	0.1	0.1	3.1	3.0	0.1	0.2	2.1	47.1	11.0	1.8	8.4	0.0	0.0	1.3
0.2	20.5	0.1	0.1	29.0	41.2	0.1	0.2	30.1	82.8	19.0	45.7	72.8	0.0	0.0	8.6
0.4	23.1	0.1	0.1	54.3	57.9	2.3	0.6	99.4	98.2	21.7	77.3	99.5	0.0	0.0	56.1
0.8	33.8	0.6	0.2	57.4	58.4	16.1	2.0	99.8	100.0	32.0	99.0	100.0	0.5	1.6	93.0
1.6	47.6	11.1	1.2	60.2	59.6	49.8	9.6	100.0		50.3	100.0		19.8	17.2	98.4
3.15	56.4	46.4	41.8	61.0	61.8	80.4	23.0			62.0			75.7	64.0	99.0
6.3	64.6	67.5	88.0	61.0	63.2	87.2	33.1			72.2			99.7	95.8	99.5
12.5	71.5	72.4	89.7	61.8	63.9	88.5	43.0			81.6			100.0	99.5	99.7
25.0	84.5	74.0	91.0	63.1	64.2	88.8	54.2			90.7				100.0	100.0
50	93.9	77.0	98.7	68.6	64.8	89.5	59.1			96.8					
100	98.6	83.6	99.7	80.7	65.9	90.3	100.0			98.8					
>100	100.0	100.0	100.0	100.0	100.0	100.0				100.0					

1969~1971, number of strains 908, * 1970~1971, number of strains 383

Table 3. *S. aureus* isolated from sputum.

MIC μg/ml	PC-G	SM	CP	TC	EM	KM	SMX	CET	CER	ABPC	GM*	MIPC*	CEG*	CE X*	CEZ*
	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
0.0125	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	0.0	0.0	0.0	0.0	0.0	0.0
0.025	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	0.0	0.0	0.0	0.0	0.0	0.0
0.05	4.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.8	1.5	0.0	0.0	0.0	0.0	0.0
0.1	13.8	0.0	0.0	0.0	3.1	0.0	0.0	1.5	46.2	6.2	0.0	0.0	0.0	0.0	0.0
0.2	13.8	0.0	0.0	26.2	30.8	0.0	0.0	32.3	70.8	12.3	4.2	45.8	0.0	0.0	0.0
0.4	18.5	0.0	0.0	63.1	60.0	0.0	0.0	96.9	95.4	13.8	41.7	100.0	0.0	0.0	41.7
0.8	29.2	0.0	0.0	64.6	61.5	3.1	3.2	100.0	100.0	23.1	83.3		0.0	0.0	83.3
1.6	41.5	3.1	1.5	67.7	64.6	40.0	14.5			46.2	100.0		12.5	0.0	100.0
3.15	50.8	27.7	29.2	67.7	66.2	80.0	29.0			58.5			91.7	50.0	
6.3	61.5	61.5	81.5	67.7	67.7	92.3	46.8			70.8			100.0	87.5	
12.5	64.6	75.4	89.2	67.7	69.2	93.8	59.7			81.5				100.0	
25.0	73.8	76.9	90.8	69.2	69.2	93.8	66.1			89.2					
50	87.7	78.5	96.9	69.2	69.2	93.8	66.1			92.3					
100	96.9	84.6	100.0	78.5	69.2	95.4	100.0			95.4					
>100	100.0	100.0	100.0	100.0	100.0	100.0				100.0					

1969~1971, number of strains 65, * 1970~1971, number of strains 24.

Table 4. *S. aureus* isolated from pharyngeal mucus specimens.

MIC μg/ml	PC-G	SM	CP	TC	EM	KM	SMX	CET	CER	ABPC	GM*	MIPC*	CEG*	CEX*	CEZ*
	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
0.0125	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0
0.025	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0
0.05	5.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	15.0	1.7	0.0	0.0	0.0	0.0	0.0
0.1	10.0	0.0	0.0	1.7	3.3	0.0	0.0	3.3	55.0	7.5	0.0	0.0	0.0	0.0	0.0
0.2	11.7	0.0	0.0	17.5	50.8	0.0	0.0	27.5	88.3	12.5	2.6	47.4	0.0	0.0	2.6
0.4	21.7	0.0	0.0	72.5	76.7	0.8	0.8	95.8	99.2	17.5	50.0	92.1	0.0	0.0	50.0
0.8	36.7	0.8	0.0	77.5	80.8	7.5	2.5	100.0	100.0	28.3	81.6	100.0	0.0	0.0	94.7
1.6	45.8	5.8	0.8	78.3	80.8	45.8	13.3			50.8	100.0		18.4	0.0	100.0
3.15	61.7	41.7	40.8	78.3	80.8	87.5	33.3			71.7			86.8	42.1	
6.3	73.3	75.8	93.3	80.8	80.8	94.2	45.8			82.5			100.0	92.1	
12.5	82.5	85.8	96.7	80.8	81.7	95.8	60.0			91.7				100.0	
25	90.0	88.3	96.7	80.8	82.5	96.7	71.7			96.7					
50	95.0	89.2	97.5	82.5	83.3	99.2	80.0			98.3					
100	98.3	93.3	100.0	88.3	83.3	99.2	100.0			99.2					
>100	100.0	100.0	100.0	100.0	100.0	100.0				100.0					

1969~1971, number of strains 120, * 1970~1971, number of strains 38.

Table 5. *E. coli* isolated from urine.

MIC μg/ml	SMX	CP	CER	CET	KM	SM	TC	ABPC	GM*	CBPC*	CEG*	CEX*	CEZ*
	%	%	%	%	%	%	%	%	%	%	%	%	%
0.0125	6.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.025	14.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.05	25.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.1	29.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
0.2	30.5	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
0.4	31.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.4
0.8	31.3	0.1	0.4	0.0	0.0	0.0	0.8	1.2	3.3	0.0	0.0	0.0	1.3
1.6	31.4	0.3	25.9	1.0	1.6	1.0	13.3	10.0	34.5	0.6	1.3	0.0	42.7
3.15	31.4	7.2	73.7	6.9	33.5	10.8	29.8	45.3	88.2	5.5	21.1	0.1	81.0
6.3	31.6	35.4	83.9	31.1	80.2	28.1	33.6	70.0	99.6	35.4	71.8	14.5	91.7
12.5	31.8	45.0	92.2	66.5	90.2	31.9	35.4	75.1	100.0	69.5	88.9	71.1	95.5
25.0	37.9	46.1	96.2	90.2	91.1	35.8	37.5	77.1		77.4	95.2	95.2	97.2
50	74.8	47.1	98.4	96.1	91.2	47.0	39.1	77.7		78.8	97.6	97.9	98.3
100	100.0	48.0	99.0	97.7	92.1	69.1	44.3	78.5		80.2	98.2	98.6	99.3
>100	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0		100.0	100.0	100.0	100.0

1969~1971, number of strains 1,152, * 1970~1971, number of strains 712.

Table 6. *E. coli* isolated from bile.

MIC μg/ml	SMX	CP	CER	CET	KM	SM	TC	ABPC	GM*	CBPC*	CEG*	CEX*	CEZ*
	%	%	%	%	%	%	%	%	%	%	%	%	%
0.0125	8.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.025	25.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.05	44.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.1	58.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.2	61.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.4	63.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.8	63.9	0.0	2.8	0.0	0.0	0.0	0.0	8.3	10.0	0.0	0.0	0.0	0.0
1.6	63.9	2.8	27.8	5.6	2.8	0.0	22.2	16.7	70.0	0.0	0.0	0.0	40.0
3.15	63.9	11.1	77.8	13.9	33.3	13.9	55.6	58.3	100.0	0.0	25.0	0.0	85.0
6.3	63.9	50.0	94.4	33.3	72.2	50.0	63.9	80.6		10.0	65.0	15.0	90.0
12.5	66.7	75.0	94.4	72.2	88.9	55.6	63.9	86.1		65.0	85.0	65.0	100.0
25.0	66.7	77.8	97.2	91.7	88.9	63.9	69.4	88.9		80.0	90.0	95.0	
50	88.9	77.8	100.0	97.2	88.9	72.2	69.4	88.9		85.0	100.0	100.0	
100	100.0	80.6		100.0	91.7	77.8	72.2	88.9		85.0			
>100	100.0	100.0		100.0	100.0	100.0	100.0	100.0		100.0			

1969~1971, number of strains 36, * 1970~1971, number of strains 20.

Table 7. *E. coli* isolated from pus.

MIC μg/ml	SMX	CP	CER	CET	KM	SM	TC	ABPC	GM*	CBPC*	CEG*	CEX*	CEZ*
	%	%	%	%	%	%	%	%	%	%	%	%	%
0.0125	6.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.025	18.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.05	28.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.1	33.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.2	34.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.4	35.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.8	35.4	0.0	2.1	0.7	0.0	0.0	1.4	0.7	10.6	0.0	0.0	0.0	3.5
1.6	35.4	0.0	28.3	0.7	1.4	0.7	12.4	13.1	75.3	0.0	3.5	0.0	60.5
3.15	35.4	8.3	76.6	13.8	29.0	6.2	35.2	51.7	100.0	3.5	31.4	1.2	86.0
6.3	35.4	43.4	86.9	38.6	75.9	28.3	39.3	75.2		41.9	81.4	22.1	94.2
12.5	35.4	53.8	95.2	77.9	89.7	33.1	40.0	82.8		72.1	95.3	81.4	96.5
25.0	38.9	54.5	96.6	91.7	91.0	35.9	40.0	84.1		77.9	95.3	96.5	97.7
50	74.3	55.2	98.6	96.6	91.0	46.9	41.4	85.5		82.6	98.8	97.7	97.7
100	100.0	57.9	98.6	97.2	91.7	69.7	46.9	86.2		82.6	98.8	97.7	98.8
>100	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0		100.0	100.0	100.0	100.0

1969~1971, number of strains, 145, * 1970~1971, number of strains 86.

Table 8. *E. coli* isolated from other specimens.

MIC μg/ml	SMX	CP	CER	CET	KM	SM	TC	ABPC	GM*	CBPC	CEG*	CEX*	CEZ*
	%	%	%	%	%	%	%	%	%	%	%	%	%
0.0125	7.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.025	20.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.05	36.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.1	41.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.2	43.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.4	44.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0
0.8	44.4	0.0	1.5	0.3	0.0	0.0	0.8	1.5	27.9	0.0	0.0	0.0	1.9
1.6	44.4	0.5	31.6	2.0	2.0	1.0	15.0	11.0	81.2	0.5	2.4	0.0	54.8
3.15	44.4	9.5	79.4	14.8	33.8	13.8	39.3	46.9	100.0	4.3	28.6	0.5	86.2
6.3	44.6	44.4	89.5	41.6	80.2	37.8	43.6	74.7		32.4	78.6	19.5	92.9
12.5	45.2	58.9	95.7	78.9	90.5	42.1	44.6	82.5		71.0	94.8	75.2	96.2
25.0	51.3	60.2	97.7	94.0	91.0	45.4	45.6	84.0		80.0	96.7	97.6	99.0
50	76.0	60.9	99.2	97.7	91.2	55.4	46.9	85.0		82.4	99.0	99.0	99.0
100	100.0	62.4	99.5	98.5	92.0	76.4	51.6	86.0		82.4	99.5	99.0	99.5
>100	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0		100.0	100.0	100.0	100.0

1969~1971, number of strains, 399, * 1970~1971, number of strains, 210.

Table 9. *S. aureus*. Sensitivity of strains in various specimens. 1969~1971

	Pus (A)		Sputum (B)		Pharyngeal mucus (C)	
	N	S	N	S	N	S
PC-G	908	18.6	65	13.8	120	10.0
SM	908	72.4	65	75.4	120	85.8
CP	907	88.0	65	81.5	120	93.3
TC	908	60.2	65	67.7	120	78.3
EM	908	57.9	65	60.0	120	76.7
KM	907	87.2	65	92.3	120	94.2
SMX	897	33.1	65	46.8	120	45.8
CET	908	99.4	65	100.0	120	100.0
CER	908	98.2	65	95.4	120	99.2
ABPC	907	19.0	65	12.3	120	12.5
GM*	383	99.0	24	83.3	38	81.6
MIPC*	383	99.5	24	100.0	38	92.1
CEG*	383	99.7	24	100.0	38	100.0
CEX*	383	95.8	24	87.5	38	92.1
CEZ*	383	98.4	24	100.0	38	100.0

* =1970~1971.
N=number of strains, S=sensitivity percent

Table 10. Test of significance of data from Table 9.

Drug	A—B	A—C	B—C
PC-G	—	*	—
SM	—	**	—
CP	—	—	*
TC	—	**	—
EM	—	**	*
KM	—	*	—
SMX	*	**	—
CET	—	—	—
CER	—	—	—
ABPC	—	—	—
GM*	**	**	—
MIPC*	—	**	—
CEG*	—	—	—
CEX*	—	—	—
CEZ*	—	—	—

* =1970~1971, **P=0.01; P=0.05, —not significant (exact probability method of R.A. FISHER)

to various antibiotics is listed in Tables 13 and 14. No significant differences were observed in *S. aureus* between isolates from out-patients and from in-patients. However, in *E. coli*, it was evident that the sensitivity of isolates from in-patients to antibiotics, especially to cephaloridine (CER), ampicillin (AB-PC), carbenicillin (CB-PC), cephaloglycine (CEG), cefazolin (CEZ) and kanamycin (KM) was less than that of isolates from out-patients.

(3) In Table 15, *S. aureus* and *E. coli* isolates are grouped according to the nature and site of infection. The distribution of sensitivity of *S. aureus* and *E. coli* in each group is presented in Tables 16~20. The percentage of sensitive strains to various antibiotics is summarized in Tables 21 and 23, and the test of significance of the values is shown in Tables

Table 11. *E. coli*. Sensitivity of strains in various specimens. 1969~1971.

	Urine (A)		Pus (B)		Bile (C)		Other (D)	
	N	S	N	S	N	S	N	S
SMX	1126	30.5	144	34.0	36	61.1	350	43.1
CP	1154	45.0	145	53.8	36	75.0	354	58.2
CER	1154	83.9	145	86.9	36	94.4	354	88.1
CET	1154	90.2	145	91.7	36	91.7	354	93.2
KM	1154	90.2	145	89.7	36	88.9	354	90.1
SM	1154	28.1	145	28.3	36	50.0	354	37.3
TC	1154	33.6	145	39.3	36	63.9	354	43.8
ABPC	1154	75.1	145	82.8	36	86.1	354	81.9
GM*	693	99.6	85	100.0	20	100.0	195	100.0
CBPC*	712	77.4	86	77.9	20	80.0	197	78.7
CEG*	712	88.9	86	75.3	20	85.0	197	94.4
CEX*	712	95.2	86	96.5	20	95.0	197	97.5
CEZ*	702	82.2	86	86.0	20	85.0	197	92.4

* =1970~1971, N=number of strains, S=sensitivity percent

Table 12. Test of significance of data from Table 11

	A—B	A—C	A—D	B—C
SMX	—	**	**	**
CP	*	**	**	*
CER	—	—	*	—
CET	—	—	*	—
KM	—	—	—	—
SM	—	**	**	*
TC	—	**	**	**
ABPC	*	—	**	—
GM*	—	—	—	—
CBPC*	—	—	—	—
CEG*	*	—	*	—
CEX*	—	—	—	—
CEZ*	—	—	—	—

* =1970~1971
** P=0.01; *P=0.05; —not significant (exact probability method of R.A. FISHER)

Table 13. Sensitivity of isolates from out-patients and in-patients and results of significance test. *S. aureus* (1970~1971)

	In-patients (A)		Out-patients (B)		Significance
	N	S	N	S	A—B*
PC-G	172	16.3	262	20.6	—
SM	172	73.3	262	78.6	—
CP	172	84.9	262	87.8	—
TC	172	64.0	262	71.4	—
EM	172	55.8	262	61.1	—
KM	172	86.0	262	88.9	—
SMX	166	27.1	262	26.2	—
CET	172	100.0	262	98.9	—
CER	172	97.1	262	96.9	—
GM	172	95.9	262	96.9	—
ABPC	171	18.1	262	19.5	—
MIPC	172	99.4	262	98.5	—
CEG	172	100.0	262	99.6	—
CEX	172	93.0	262	96.2	—
CEZ	172	98.3	262	98.9	—

N=Number of strains, S=Sensitivity percent.
* Significance by exact probability method of R.A. FISHER
—indicates not significant.

22 and 23.

In *S. aureus*, isolates from infections of skin and soft tissues were more sensitive to KM and SM than those from otorhinological infections. On the other hand, isolates from infections of skin and soft tissues were less sensitive to TC and GM than those from infections of respiratory tracts. Isolates from infections of respiratory tracts were more sensitive to erythromycin (EM), KM than those from otorhinological infections.

In *E. coli*, it was found that isolates from

Table 14. Sensitivity of isolates from out-patients and in-patients and results of significance test. *E. coli* (1970~1971)

	In-patients (A)		Out-patients (B)		Significance A—B
	N	S	N	S	
SMX	445	30.1	409	30.8	—
CP	455	41.5	420	46.2	·
CER	455	79.1	420	85.2	*
CET	455	86.4	420	89.3	—
GM	448	99.3	406	100.0	—
KM	455	83.5	420	93.3	**
SM	455	25.1	420	28.1	—
TC	455	33.2	420	35.2	—
ABPC	455	71.6	420	80.5	**
CBPC	455	73.0	420	81.7	**
CEG	455	87.7	420	92.1	*
CEX	455	94.5	420	96.7	·
CEZ	455	89.2	420	94.3	**

**P=0.01; *P=0.05; ·P=0.1; —not significant
N=Number of strains, S=Sensitivity percent

infections of the bile duct were more sensitive to TC, SMX, CP and SM than those from infections of urinary tract.

(4) The isolates of *S. aureus* and *E. coli* were grouped into 4 groups according to the size of the population of district from which the strains were isolated. District A is the most densely populated and it is assumed that the quantity of antibiotics used in this district is greater than that in other districts. In Table 24, number of hospitals from which the strains were isolated and number of strains isolated are listed. As shown in Table 25, number of strains of *S. aureus* sensitive to penicillin G (PC-G) and AB-PC in district A was much lower than that in district D. On the other hand, number of strains of *S. aureus* sensitive to SM and EM in district A was higher than

Table 15. The kinds of main infections and diseases, and number of isolates of *S. aureus* and *E. coli*. 1969~1971. ( )···1970~1971.

	Infections	Name of diseases	Strains	
			Number	%
S. aureus	Infections of skin and soft tissue (Pus)	Carbuncle	61 (32)	26 (28)
		Furuncle	41 (18)	18 (16)
		Infections of soft tissue	32 (9)	14 (8)
		Impetigo	13 (6)	6 (5)
		Phlegmon	11 (6)	5 (5)
		Others	75 (42)	32 (29)
			233 (113)	100 (100)
	Otorhinological infection (Pus)	Otitis media	125 (55)	80 (80)
		Otitis externa	12 (6)	8 (9)
		Sinusitis	0 (2)	0 (3)
		Others	19 (6)	12 (10)
			156 (69)	100 (100)
	Infections of respiratory tracts (Pus, sputum, pharyngeal mucus)	Tonsillitis	26 (11)	24 (26)
		Pneumonia	14 (7)	13 (17)
		Pharyngitis	12 (5)	11 (12)
		Angina	5 (4)	5 (10)
		Others	53 (5)	47 (12)
			110 (42)	100 (100)
E. coli	Infections of urinary tract (Urine)	Cystitis	393 (239)	53 (52)
		Pyelonephritis	191 (125)	36 (27)
		Urine tract inf.	83 (50)	11 (11)
		Others	69 (42)	9 (9)
			736 (456)	100 (100)
	Cholecystitis (Bile)	Cholecystitis	13 (8)	52 (61)
		Others	12 (5)	48 (39)
			25 (13)	100 (100)

Table 16. *S. aureus.* Infection of skin and soft tissue.

MIC μg/ml	PC-G	AB-PC	SM	KM	TC	CP	EM	CER	CET	SMX	GM*	MCI-P*	CEX*	CEG*	CEZ*
	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
0.025	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0
0.05	11	0	0	0	0	0	0	18	0	0	0	0	0	0	0
0.1	18	11	0	0	3	0	2	48	2	0	2	10	0	0	1
0.2	21	20	0	0	27	0	39	79	28	0	45	73	0	0	10
0.4	23	23	0	3	56	0	58	98	92	0	79	100	0	0	66
0.8	35	31	1	18	58	0	58	100	99	0	99		2	1	91
1.6	49	49	11	52	61	1	61	100	100	1	100		20	25	97
3.15	57	62	51	82	61	42	63	100	100	8			65	75	98
6.3	64	71	72	89	61	85	64	100	100	22			96	100	99
12.5	70	80	76	90	62	89	65	100	100	32			100		99
25.0	82	90	79	90	64	91	65	100	100	46					100
50.0	95	97	80	91	71	100	66	100	100	57					
100	99	99	87	92	82	100	67	100	100	62					
>100	100	100	100	100	100	100	100	100	100	100					

Number of strains 233 (1969~1971) * Number of strains 113 (1970~1971)

Table 17. *S. aureus.* Otorhinological infection.

MIC μg/ml	PC-G	AB-PC	SM	KM	TC	CP	EM	CER	CET	SMX	GM*	MCI-P*	CEX	CEG	CEZ
	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
0.025	1	0	1	0	0	0	0	0	1	0	0	0	0	0	0
0.05	10	0	1	0	0	0	0	15	1	0	0	9	0	0	0
0.1	16	6	1	0	3	0	4	50	3	0	1	71	0	0	3
0.2	17	15	1	0	26	0	35	83	33	0	22	99	0	0	6
0.4	21	18	1	1	53	0	54	97	91	1	57	100	1	0	49
0.8	33	32	1	8	60	0	56	100	99	1	97		10	16	93
1.6	51	56	7	42	63	1	58		99	14	100		67	74	100
3.15	59	67	41	71	63	35	60		100	22			96	99	
6.3	68	77	59	77	63	85	62			31			99	100	
12.5	74	83	67	80	64	87	62			42			100		
25.0	87	92	70	80	66	88	62			53					
50	92	97	72	81	71	97	62			59					
100	98	99	76	82	83	100	63			100					
>100	100	100	100	100	100		100								

Number of strains 156 (1969~1971) * Number of strains 69 (1970~1971)

Table 18. *S. aureus.* Infections of respiratory tract.

MIC μg/ml	PC-G	AB-PC	SM	KM	TC	CP	EM	CER	CET	SMX	GM*	MCI-P*	CEX*	CEG*	CEZ*
	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
0.025	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0
0.05	6	1	0	0	0	0	0	13	0	0	0	0	0	0	0
0.1	13	10	0	0	3	0	4	50	4	0	0	0	0	0	0
0.2	15	15	0	0	25	0	41	82	30	0	14	55	0	0	2
0.4	22	17	0	0	65	0	65	97	97	0	52	95	2	0	50
0.8	35	30	0	11	69	0	68	100	100	2	88	100	7	0	93
1.6	43	48	4	46	72	3	68			12	100		55	12	100
3.15	56	64	35	82	73	36	70			26			90	90	
6.3	67	77	67	90	75	90	71			40			100	100	
12.5	76	88	75	92	75	95	72			53					
25.0	84	92	77	93	75	95	73			63					
50.0	95	95	81	95	76	98	73			68					
100	97	98	86	96	83	100	73			100					
>100	100	100	100	100	100		100								

Number of strains 110 (1969~1971) * Number of strains 42 (1970~1971)

Table 19. *E. coli*. Infections of urinary tract.

MIC μg/ml	TC	CP	SM	KM	AB-PC	CET	CER	SMX	GM*	CB-PC*	CEX*	CEG*	CEZ*
	%	%	%	%	%	%	%	%	%	%	%	%	%
0.025	0	0	0	0	0	0	0	14	0	0	0	0	0
0.05	0	0	0	0	0	0	0	26	0	0	0	0	0
0.1	0	0	0	0	0	0	0	31	0	0	0	0	0
0.2	0	0	0	0	0	0	0	31	0	0	0	0	0
0.4	0	0	0	0	0	0	0	32	0	0	0	0	0
0.8	1	0	0	0	1	0	0	32	36	0	0	0	1
1.6	13	0	1	1	11	1	27	32	88	1	0	2	44
3.15	29	8	12	36	45	7	73	32	100	7	0	22	81
6.3	34	38	28	80	70	31	85	32		36	14	72	92
12.5	36	48	33	91	76	66	92	32		70	71	88	95
25.0	38	49	37	92	78	90	96	36		77	96	95	97
50.0	40	50	48	92	79	96	98	75		79	98	97	98
100	46	50	69	93	79	98	99	100		81	99	98	99
>100	100	100	100	100	100	100	100			100	100	100	100

Number of strains 736 (1969~1971) * Number of strains 456 (1970~1971)

Table 20. *E. coli*. Cholecystitis.

MIC μg/ml	TC	CP	SM	KM	AB-PC	CET	CER	SMX	GM*	CB-PC*	CEX*	CEG*	CEZ
	%	%	%	%	%	%	%	%	%	%	%	%	%
0.025	0	0	0	0	0	0	0	20	0	0	0	0	0
0.05	0	0	0	0	0	0	0	40	0	0	0	0	0
0.1	0	0	0	0	0	0	0	56	0	0	0	0	0
0.2	0	0	0	0	0	0	0	56	0	0	0	0	0
0.4	0	0	0	0	0	0	0	56	0	0	0	0	0
0.8	0	0	0	0	12	0	4	56	8	0	0	0	0
1.6	28	4	0	4	20	8	28	56	69	0	0	0	31
3.15	68	16	20	40	60	20	76	56	100	0	0	23	85
6.3	72	56	52	64	80	40	96	56		0	15	62	92
12.5	72	72	56	84	88	72	96	60		62	62	85	100
25.0	76	76	60	84	92	92	96	60		85	92	92	
50.0	76	76	72	84	92	100	100	84		85	100	100	
100	76	76	76	88	92			100		85			
>100	100	100	100	100	100					100			

Number of strains 25, (1969~1971) * Number of strains 13 (1971~1971)

that in district B, C and D. In district B, C and D, no significant difference in sensitivity to various antibiotics was observed except that fewer strains sensitive to SM were isolated in district C.

Results for *E. coli* are shown in Table 27. With most antibiotics no significant difference in sensitivity was observed among the four districts. The test of significance of the values listed in Tables 25 and 27 is shown in Tables 26 and 28, respectively.

(5) The isolated strains were grouped into 3 groups according to the size of the hospitals from which the strains were isolated. University hospitals were grouped in A. The average number of beds in group A was 600. Other hospitals were grouped in B and C. The average number of beds of group B and C was 400 and 150, respectively.

The number of hospitals studied and number of strains isolated in each group is shown in Table 29. The differences in sensitivity among the three groups of *S. aureus* and *E. coli* isolates are shown in Tables 30 and 32. In *S. aureus*, fewer sensitive strains to SMX and CEZ were found in group C. In *E. coli* a higher percentage of strains sensitive to most antibiotics studied including SMX, CP, CER, KM, TC, AB-PC and CB-PC was found in group B and C. The test of significance of the values listed in Tables 30 and 32 is shown in Tables 31 and 33 respectively.

Table 21. *S. aureus*. Sensitivity of strains and type of infection strains isolated (1969~1971)
A=Infections of skin and soft tissues; B=Otorhinological infection; C=Infections of respiratory tract

	A		B		C	
	N	S	N	S	N	S
PC-G	233	17.6	156	16.0	110	12.7
SM	233	76·0	156	67.3	110	74.5
CP	233	85.4	156	85.3	110	90.0
TC	233	60.5	156	62.8	110	71.8
EM	233	57.9	156	53.8	110	65.5
KM	233	88.8	156	76.9	110	90.0
SMX	233	32.3	156	30.5	110	40.0
CET	233	99.1	156	99.4	110	100.0
CER	233	97.9	156	96.8	110	97.3
ABPC	233	19.7	156	15.4	110	14.5
GM*	113	99.1	69	97.1	42	88.1
MIPC*	113	100.0	69	98.6	42	95.2
CEG*	113	100.0	69	98.6	42	100.0
CEX*	113	96.5	69	95.7	42	90.5
CEZ*	113	97.3	69	100.0	42	100.0

* isolated in 1970~1971.
N=Number of isolates, S=Sensitivity percent.

Table 22. Test of significance of data from Table 21.

	A—B	A—C	B—C
PC-G	—	—	—
SM	*	—	—
CP	—	—	—
TC	—	*	—
EM	—	—	*
KM	**	—	**
SMX	—	—	—
CET	—	—	—
CER	—	—	—
ABPC	—	—	—
GM*	—	**	—
MIPC*	—	—	—
CEG*	—	—	—
CEX*	—	—	—
CEZ*	—	—	—

* isolated in 1970~1971.
**P=0.01; *P=0.05; —not significant (exact probability method of R.A. FISHER).

Table 23. *E. coli*. Sensitivity of strains, type of infection and test of significance strains isolated (1969~1971)
A=Infections of urinary tract, B=Infections of bile duct

	A		B		Significance A-B
	N	S	N	S	
SMX	718	31.2	25	56.0	*
CP	736	47.6	25	72.0	*
CER	736	84.6	25	96.0	—
CET	736	90.1	25	92.0	—
KM	736	90.8	25	84.0	—
SM	736	28.4	25	52.0	*
TC	736	33.8	25	72.0	**
ABPC	736	76.0	25	88.0	—
GM*	447	100.0	13	100.0	—
CBPC*	456	77.4	13	84.6	—
CEG*	456	88.4	13	84.6	—
CEX*	456	95.8	13	92.3	—
CEZ*	456	91.7	13	92.3	—

* isolated in 1970~1971
N=number of strains, S=sensitivity percent.
**P=0.01; *P=0.05; —=not significant
(exact probability method of R.A. FISHER)

Discussion

Using strains of *S. aureus* and *E. coli* isolated from various clinical specimens the difference in sensitivity to various antibiotics was studied in relation to the source of the isolates. The number of strains studied in this paper was about 82% in *S. aureus* and about 70% in *E. coli* of all isolated strains. The strains studied were assumed to be a causative agent of the clinical symptoms.

In *S. aureus*, isolates from pus were most resistant and isolates from pharyngeal mucus were most sensitive to the various antibiotics studied.

The results with *S. aureus* showing no significant difference in antibiotic sensitivity between isolates from out-patients and from in-patients were unexpected. On the other hand, as was expected, the sensitivity of isolates of *E. coli* from in-patients was lower than that of isolates from out-patients. This was especially evident with CER, AB-PC, CB-PC, CEG and CEZ, which were introduced recently in clinical usage.

It is noteworthy that *S. aureus* isolates from

Table 24. Districts, number of hospitals and number of isolates (1970~1971)

	District	A	B	C	D	Total
S. aureus	no. of hospitals	42 (22%)	27 (14%)	15 (8%)	107 (56%)	197
	no. of strains	110 (25%)	67 (15%)	32 (7%)	238 (53%)	447
E. coli	no. of hospitals	67 (22%)	41 (13%)	32 (10%)	172 (55%)	312
	no. of strains	213 (23%)	118 (13%)	86 (9%)	501 (54%)	897

A=most densely populated district. B=less densely populated district C=Kyushu district D=Other districts

Table 25. *S. aureus*. Sensitivity of isolates from different districts. (1970~1971)

	A		B		C		D	
	N	S	N	S	N	S	N	S
PC-G	110	12.7	67	19.4	32	18.8	238	22.7
SM	110	86.4	67	74.1	32	59.4	238	75.2
CP	110	88.2	67	83.6	32	93.8	236	86.8
TC	110	78.2	67	67.2	32	53.1	238	66.8
EM	110	70.9	67	49.3	32	46.9	238	59.2
KM	110	90.0	67	89.6	32	81.3	238	87.8
SMX	107	36.4	64	26.6	31	19.4	233	21.9
CET	110	100.0	67	97.0	32	100.0	238	99.6
CER	110	96.4	67	98.5	32	100.0	238	96.6
GM	110	96.4	67	95.5	32	100.0	238	96.6
ABPC	110	11.8	66	21.2	32	21.9	238	22·7
MIPC	110	100.0	67	98.5	32	100.0	238	98.3
CEG	110	100.0	67	100.0	32	100.0	238	99.6
CEX	110	94.5	67	95.5	32	96.9	238	95.4
CEZ	110	100.0	67	100.0	32	100.0	238	97.5

A=most densely populated district. B=less densely populated district. C=Kyushu district. D=Other districts N=number of strains S=sensitivity percent

Table 26. Test of significance of data from Table 25

	A-B	A-C	A-D	B-C	B-D	C-D
PC-G	—	—	*	—	—	—
SM	*	**	*	—	—	*
CP	—	—	—	—	—	—
TC	—	**	*	—	—	—
EM	**	*	*	—	—	—
KM	—	—	—	—	—	—
SMX	—	—	**	—	—	—
CET	—	—	—	—	—	—
CER	—	—	—	—	—	—
GM	—	—	—	—	—	—
ABPC	—	—	*	—	—	—
MIPC	—	—	—	—	—	—
CEG	—	—	—	—	—	—
CEX	—	—	—	—	—	—
CEZ	—	—	—	—	—	—

**P=0.01; *P=0.05; —not significant
(exact probability method of R.A. FISHER)

infections of skin and soft tissues were more sensitive to KM and other aminoglycosides than were those from otorhinological infections. It is also interesting that *E. coli* isolates from infections of the urinary tract were more resistant than those isolated from infections of the bile duct.

It was found that the number of strains of *S. aureus* sensitive to PC-G and AB-PC in district A, where the population was large and where hospitals of large size were located, was much lower than that in other districts. This may be due to the fact that these antibiotics are more frequently used in district A. In *E. coli*, no significant differences were observed among each district. It will be imaginable that these resistant plasmids are dis-

Table 27. *E. coli*. Sensitivity of isolates from different districts. (1970~1971)

	A		B		C		D	
	N	S	N	S	N	S	N	S
SMX	209	28.7	117	26.5	85	30.6	486	32.7
CP	213	44.1	118	41.5	86	46.5	501	45.5
CER	213	82.2	118	82.2	86	83.7	501	82.8
CET	213	88.3	118	89.8	86	89.5	501	87.8
GM	209	98.6	118	100.0	86	100.0	484	100.0
KM	213	88.7	118	89.0	86	91.9	501	88.0
SM	213	24.4	118	30.5	86	30.2	501	27.3
TC	213	35.2	118	33.9	86	40.7	501	33.5
ABPC	213	76.5	118	75.4	86	76.7	501	77.2
CBPC	213	77.0	118	78.0	86	77.9	501	78.4
CEG	213	89.7	118	92.4	86	91.9	501	89.8
CEX	213	95.8	118	99.2	86	93.0	501	95.4
CEZ	213	93.4	118	94.1	86	90.7	501	91.2

N=number of strains. S=sensitivity percent. A=most densely populated district. B=less densely populated district. C=Kyushu district. D=other districts

Table 28. Test of significance of data from Table 27.

Drug	A—B	A—C	A—D	B—C	B—D	C—D
SMX	—	—	—	—	—	—
CP	—	—	—	—	—	—
CER	—	—	—	—	—	—
CET	—	—	—	—	—	—
GM	—	—	*	—	—	—
KM	—	—	—	—	—	—
SM	—	—	—	—	—	—
TC	—	—	—	—	—	—
ABPC	—	—	—	—	—	—
CBPC	—	—	—	—	—	—
CEG	—	—	—	—	—	—
CEX	—	—	—	*	*	—
CEZ	—	—	—	—	—	—

**P=0.01; *P=0.05; —not significant (exact probability method of R.A. FISHER)

Table 29. Size of hospital and number of isolates (1970~1971)

		Size of hospital			Total
		A	B	C	
S. aureus	no. of hospitals	42 (19%)	193 (65%)	33 (15%)	214
	no. of strains	91 (20%)	306 (68%)	52 (12%)	449
E. coli	no. of hospitals	69 (18%)	244 (65%)	63 (18%)	376
	no. of strains	168 (19%)	633 (70%)	92 (11%)	893

A=University hospitals; average number of beds, 600 B=Large hospitals; average number of beds, 400 C=General hospitals; average number of beds, 150

Table 30. *S. aureus*. Sensitivity of isolates from different groups of hospitals (1970~1971)

	A		B		C	
	N	S	N	S	N	S
PC-G	91	18.7	306	20.6	52	13.5
SM	91	78.0	306	76.1	52	76.9
CP	91	92.3	306	85.3	52	88.5
TC	91	69.2	306	69.9	52	59.6
EM	91	58.2	306	60.5	52	57.7
KM	91	90.1	306	87.3	52	90.4
SMX	88	21.6	297	29.3	52	13.5
CET	91	98.9	306	99.7	52	98.1
CER	91	97.8	306	96.4	52	100.0
GM	91	97.8	306	96.7	52	94.2
ABPC	90	20.0	306	20.6	52	13.5
MIPC	91	98.9	306	99.0	52	98.1
CEG	91	100.0	306	99.7	52	100.0
CEX	91	96.7	306	94.8	52	94.2
CEZ	91	100.0	306	99.0	52	94.2

A=University hospitals B=large hospitals C=general hospitals N=number of strains S=sensitivity percent.

Table 31. Test of significance of data from Table 30

	A—B	A—C	B—C
PC-G	—	—	—
SM	—	—	—
CP	—	—	—
TC	—	—	—
EM	—	—	—
KM	—	—	—
SMX	—	—	*
CET	—	—	—
CER	—	—	—
GM	—	—	—
ABPC	—	—	—
MIPC	—	—	—
CEG	—	—	—
CEX	—	—	—
CEZ	—	*	*

**P=0.01; *P=0.05; -not significant
(exact probability method of R.A. FISHER)

Table 32. *E. coli*. Sensitivity of isolates from different groups of hospitals (1970~1971)

	A		B		C	
	N	S	N	S	N	S
SMX	168	28.6	633	30.0	96	39.6
CP	168	33.9	653	45.0	97	61.9
CER	168	80.4	653	81.8	97	92.8
CET	168	88.7	653	87.6	97	92.8
GM	164	100.0	637	99.5	96	100.0
KM	168	82.1	653	90.0	97	90.7
SM	168	22.0	653	28.0	97	32.0
TC	168	29.2	653	34.6	97	44.3
ABPC	168	73.8	653	75.8	97	88.7
CBPC	168	76.2	653	76.7	97	89.7
CEG	168	88.1	653	90.2	97	94.8
CEX	168	95.2	653	95.9	97	95.9
CEZ	168	91.7	653	91.9	97	93.8

A=University hospitals B=Large hospitals C=General hospitals N=number of strains S=sensitivity percent

Table 33. Test of significance of data from Table 32.

	A—B	A—C	B—C
SMX	—	*	*
CP	**	**	**
CER	—	**	**
CET	—	—	—
GM	—	—	—
KM	**	*	—
SM	—	—	—
TC	—	**	*
ABPC	—	**	**
CBPC	—	**	**
CEG	—	—	—
CEX	—	—	—
CEZ	—	—	—

**P=0.01; *P=0.05; —not significant
(exact probability method of R.A. FISHER)

tributing extensively in Japan.

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