when applied to unanaesthetized raw surfaces. Absolute haemostasis is essential; oozing from the wound strips up the plastic film. When it is necessary to drain a wound a gauze-and-wool dressing should be applied to the area near the drain, but the rest of the wound can be dressed with the plastic. Another minor disadvantage is that the plastic will not adhere to a wet surface. The removal of sutures is slightly more painful than with a conventional dressing, as the ends of the suture may catch in the plastic; if a continuous skin suture is used this objection does not apply. At first we applied too much dressing, with the result that a thick film formed over the wound; we now use less of the liquid, and the film which results interferes very little with the removal of skin sutures.

Advantages

The dressing can be easily applied and maintained. If it wears thin or cracks a second application of the plastic spray can be made by the ward nurse. It is transparent; therefore the wound can be inspected with ease. It is permeable to air and water vapour but impermeable to bacteria; the wound does not become moist or macerated. The dressing can be washed with soap and water; this makes it possible for the patient to take a bath days before the sutures are ready for removal. It is flexible and strong, with the result that the patient can move freely not only the thorax and abdomen during respiration but a joint such as a hip, even when the incision crosses the joint line. In our experience patients with wounds dressed in this way are more comfortable than those with conventional dressings, and after an initial period of qualified scepticism our ward sisters prefer the plastic dressings. The dressing is not irritant, and only one of the 200 wounds in this series became infected; this settled rapidly after removal of the sutures. The solution has remained sterile in its bottle or spray container during routine use in the ward and operating theatre.

The plastic film is strong and capable of withstanding considerable strain; it has not fragmented or cracked before removal of the skin sutures in any of our patients, but we have used it only on in-patients. It has been found to be of special value as a dressing for wounds of such regions as the face or scrotum, where it is difficult to hold a gauze-and-wool dressing in position; but we use it as a routine for all clean surgical incisions. The plastic actually holds the skin edges together, with the result that tension is reduced and healing appears to be more satisfactory. We have not had the opportunity of applying the plastic to the skin near to an intestinal fistula, but it provides a satisfactory dressing for the incision near to a colostomy.

Of particular importance is the cost. This plastic sells at 0.84 of a penny per ml.—2½d. for the average abdominal incision. A gauze-and-wool dressing held in position by ½-in. (1.25-cm.) adhesive strapping also costs about 2½d. for a similar incision, but it has to be renewed at least once during each patient's stay in hospital. In our view the use of this plastic should reduce the cost of dressings for clean surgical incisions by at least 20%, and it saves the staff much time and trouble.

Conclusions

This liquid plastic appears to have advantages over conventional gauze-and-wool dressings and other plastic substances.

Its special advantages include easy application, cheapness, easy wound inspection, increased comfort for the patient, and less work for the nursing staff.

Its main disadvantages are that haemostasis must be complete, although time spent achieving this rarely harms the patient. Also, the removal of sutures is made more difficult if too thick a layer of plastic has been applied.

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SUXAMETHONIUM SENSITIVITY IN HEALTH AND DISEASE

A CLINICAL EVALUATION OF PSEUDO-CHOLINESTERASE LEVELS

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Suxamethonium chloride (succinylcholine chloride; "scoline") has an established place among the synthetic compounds which have been introduced to produce muscle relaxation during anaesthesia. Immediate and absolute muscular relaxation, flexible and easily graduated effect, associated with rapid recovery and absence of secondary actions, satisfy many of the criteria of an ideal drug.

Disturbing reports have appeared, however, of unexpectedly prolonged action following therapeutic doses. It has been established that the drug is hydrolysed by serum pseudo-cholinesterase (Ps.ChE.), and Bourne *et al.* (1952), Evans *et al.* (1952a), and Bourne (1953) found low Ps.ChE. levels in the sera of patients showing delayed recovery. Bourne (1953) suggested that the dose should be regulated by body weight, citing the work of Thesleff (1952), and thought that in "frail" patients this dose should be reduced. Evans *et al.* (1952b) demonstrated an inverse relationship between this Ps.ChE. level and the duration of action of the relaxant, and later the same authors (1953) found that injections of a purified Ps.ChE. shortened this action. They advised against giving suxamethonium to patients likely to have a low serum Ps.ChE. level such as may be found in anaemia, liver disease, and after poisoning with insecticides and war gases. Lehmann (1952) thought that the use of the drug would be safe if these patients and those suffering from malnutrition were excluded from treatment. Macintosh (1953), however, found that undernourished and anaemic Asians showed no greater susceptibility to the drug.

During employment of suxamethonium in abdominal surgery, it seemed that the responses encountered, especially among anaemic patients, were not altogether in accordance with the suggested criteria. It appeared necessary to re-examine the clinical factors concerned. This investigation, therefore, was to consider the relationship between Ps.ChE. levels, body weight, and duration of action of the drug, and to determine whether exclusion from treatment of any particular condition, particularly anaemia, was warranted. This paper presents the association found between clinical fitness, Ps.ChE. levels, and suxamethonium sensitivity, and the conclusions drawn therefrom.

Material and Methods

The haemoglobin and Ps.ChE. levels were estimated in 114 patients (56 female, 58 male) from the adult surgical wards before operation. No selection was made except to exclude patients suffering from liver disease or clinical malnutrition, and, owing to technical difficulties, some emer-

gency admissions. The conditions from which these patients suffered, in groups of clinical health (Saklad, 1941; Nosworthy, 1943), are shown in Table I.

TABLE I.—*Clinical Conditions and Operative Procedures of 114 Patients Taken at Random Except for the Exclusion of the Conditions Specified in the Text*

Operation	Clinical Condition			
	Good	Fair	Poor	Serious
Gastric	5	4	7	4
Other abdominal .. .	5	11	4	4
Genito-urinary .. .	9	8	7	1
Herniorrhaphies .. .	28	1	1	1
Other .. .	28	7	1	1
Total ..	52	31	20	11

The duration of apnoea following suxamethonium administration was accurately measured on many occasions. Adult patients were anaesthetized with from 0.2 to 0.25 g. of intravenous thiopentone and were stabilized on nitrous oxide, 5.5 litres a minute, and oxygen, 2.5 litres a minute, before the intravenous injection of suxamethonium, 0.7 mg. per kg. body weight. During the apnoea controlled respirations at a rate of 12 to 15 a minute were maintained with a mask and manual inflation of the rebreathing bag.

The haemoglobin was estimated by the alkaline haematin method (King, 1951), using a photoelectric colorimeter and corrected to a scale in which 100% equalled 14.8 g. haemoglobin per 100 ml. of blood.

The Ps.ChE. estimations were performed with the colorimetric method described by Huerga *et al.* (1952), which is based on the hydrolysis of acetylcholine bromide in a buffered solution under standard conditions. The results are expressed in micromols of acetylcholine bromide hydrolysed per hour per millilitre of serum. This technique is simple compared with previous methods which require accurate pH measurement or Warburg gas analysis, and comes within the scope of any hospital biochemical laboratory. A single emergency result is available in one and a half hours. Our coefficient of deviation of duplicate tests was ± 1.4 . These Ps.ChE. estimations were undertaken by one of us (J. H.) at the Central Laboratory, Portsmouth.

Huerga found that the values in 132 normal individuals ranged from 130 to 310 micromols: in the present investigation the values in 60 healthy individuals varied between 135 and 280 micromols.

Suxamethonium chloride ("scoline") was used in all cases.

Results

Influence of Ps.ChE. Levels on Duration of Effect.—The duration of apnoea was plotted against the Ps.ChE. level for 31 subjects (Fig. 1). It confirmed the inverse relationship described previously.

FIG. 1.—Relation of duration of apnoea following suxamethonium (0.7 mg. per kg. body weight) to serum pseudo-cholinesterase level.

The Dose/Body-Weight Relationship.—The duration of apnoea was measured in 118 adult patients receiving 0.8 to 1.3 mg. per kg. body weight (Fig. 2), and in 50 adult patients receiving 0.7 mg. per kg. body weight (Fig. 3). It confirmed that in adults an increase in dose produces an increase in action (Bourne, 1953; Thesleff, 1952). In small children it appears that comparable doses based on body weight have a shortened action. Further work is being done in this respect, and a possible explanation is discussed later.

Range of Ps.ChE. Levels in Pre-anaesthetic Patients.—Fig. 4 represents the incidence of Ps.ChE. levels in the 114 unselected patients. Compared with the normal range of 130 to 310 micromols/hour/ml., subnormal levels were found in 19% of patients. Table II shows the clinical conditions encountered in the 22 patients with subnormal levels. Nineteen were classified as "ill," ten of these as "serious"; three came within the "fair" group, but these suffered from conditions requiring semi-urgent or urgent admission to hospital. In the ill patients no obvious correlation could be found between the subnormal levels and the diseases

FIG. 2.—Relation of duration of apnoea to dose of suxamethonium (0.8–1.3 mg. per kg.)

FIG. 3.—Relation of duration of apnoea to dose of suxamethonium (0.7 mg. per kg.)

present. Although anaemia was present in 12 patients in this series and its incidence is significantly higher than in the healthier groups, it should be noted that when the whole series (114 patients) was considered 48% of those with unsatisfactory haemoglobin levels—that is, less than 80%—had normal Ps.ChE. levels. Exclusion from treatment with suxamethonium of these patients on the grounds of anaemia alone would have been unjustified.

Relationship of Haemoglobin to Ps.ChE. Levels.—The Ps.ChE. levels were plotted against the corresponding haemoglobin percentages (Table III). Although a general relationship was apparent, a very wide scatter occurred. Of the patients with a haemoglobin content over 80%, subnormal Ps.ChE. levels were found in 10%; these cases might have been accepted as safe (Lehmann, 1952), when in fact subnormal Ps.ChE. was present. The few patients with haemoglobin values below 40% were all found to have Ps.ChE. levels within the normal range. In spite of the significant correlation

FIG. 4.—Incidence of serum pseudo-cholinesterase levels in 114 pre-operative patients.

present between these two values (correlation coefficient = +0.47), the enzyme level found for each 10% range of haemoglobin content showed that in these 114 patients the presence or absence of anaemia was an unreliable index of the Ps.ChE. activity owing to the wide ranges occurring.

Relationship of Clinical State to Ps.ChE. Levels.—It became clear during analysis of these results that there was a relationship between the Ps.ChE. level and the clinical health groups into which the patients had been classified (Table IV). No low levels were found in the obviously clinically healthy and, although fewer patients were observed in the lower grades of health, the increased incidence therein of low enzyme levels became significant. Of the seriously ill patients 81.8% had subnormal levels, while the two patients with levels within the normal range were at the lowest limits of normality. Of those classified as "poor" 50% were found to have subnormal levels, while the remainder all fell within the lower third of the normal range. When more crudely grouped as "ill" and "healthy" 61.3% of the former, but only 3.6% of the latter, were subnormal. Examined statistically a very high degree of significance between these two groups is obtained ($P < 0.01$).

A further 18 patients who were selected as coming within the two lower health groups were studied. Of these ("poor" 7, "serious" 11), 14 were within the subnormal range of Ps.ChE. levels and three were within the lowest normal range (130, 138, and 138 micromols). The last patient was classified as poor as she suffered from toxæmia associated with a septic abortion. Her high Ps.ChE. level of 198 micromols was unexpected, but she showed unusual powers of recovery and was discharged within seven days.

TABLE II.—*Diseases Found in Patients Who Had Subnormal Serum Ps.ChE. Levels*

Sex	Age	Primary Condition	Secondary Condition	Hb %	Health Group	Serum Ps.ChE. Level*
M	42	Empyema	Toxaemia	81	Serious	10
F	62	Carcinoma (gastric)	Haematemesis	64	"	50
F	50	" (sigmoid)	Melaena	68	"	60
M	81	Retention of urine	Uraemia	64	Poor	63
F	43	Obstruction (large bowel)		64	Serious	73
M	54	Carcinoma (gastric)	Debilitation	45	"	88
M	63	Appendix abscess		86	Fair	90
F	44	Gastric ulcer	Haematemesis	66	Serious	90
M	60	Abdominal investigation	Depressive psychosis	110	Fair	92
M	75	Enlarged prostate	Haematuria	46	Poor	98
M	64	Gastric ulcer	Enlarged prostate	63	"	98
M	62	Carcinoma (gastric)	Haematemesis	53	Serious	100
M	59	" (sigmoid)	Hydronephrosis	68	"	100
F	26	Thyroiditis		79	Fair	100
F	50	Carcinoma (cervix)	Post-radiotherapy	80	Poor	103
F	60	Obstruction (small bowel)	Abdominal secondaries	95	"	105
M	83	Retention of urine	Coronary thrombosis	86	Serious	113
M	64	Gastric ulcer	Jejunostomy	88	Poor	119
F	48	Gummatous infiltration of peritoneum		57	"	120
F	32	Tuberculous pyonephrosis		87	"	123
M	18	Acute appendicitis	Pulmonary phthisis	98	"	125
M	67	Gastric ulcer	Haematemesis	35	"	130

* In micromols/hour/ml.

TABLE III.—*Relationship of Haemoglobin Content and Serum Ps.ChE. Level in 114 Pre-operative Patients*

Hb Group %	Ps.ChE. Range	Ps.ChE. Mean	Ps.ChE. Scatter Diagram (micromols/hour/ml.)												Total No. of Cases
			0–	25–	50–	75–	100–	125–	150–	175–	200–	225–	250–	275–	
101–	92–265	200	—	—	—	1	—	3	3	2	5	5	4	—	23
91–	105–275	188	—	—	—	—	2	5	6	14	7	4	2	1	41
81–	90–255	173	—	—	—	1	3	2	4	3	6	1	1	—	21
71–	10–230	141	1	—	—	—	2	4	1	1	1	—	—	—	11
61–	50–193	106	—	—	3	2	1	—	—	2	—	—	—	—	8
51–	63–180	123	—	—	1	—	1	—	1	1	—	—	—	—	4
41–	88–135	107	—	—	—	2	—	1	—	—	—	—	—	—	3
31–	130–190	157	—	—	—	—	—	1	1	1	—	—	—	—	3
Total ..	10–275	173	1	0	4	6	9	16	16	24	19	11	7	1	114

Correlation coefficient = +0.47.

TABLE IV.—*Relation Between the Clinical Condition of a Patient and the Serum Ps.ChE. Level*

	Clinical Condition of Patient				Total
	Healthy		Ill		
	Good	Fair	Poor	Serious	
No. of cases with normal Ps.ChE.	52	28	10	2	92
No. of cases with subnormal Ps.ChE.	—	3	10	9	22
Percentage in clinical groups with subnormal Ps.ChE.	0	9.7	50	81.8	19.3
	3.6		61.3		
Range of Ps.ChE. values in each clinical group ..	135–275	90–265	63–180	10–145	10–275
Mean and standard deviation in each group ..	207 ± 34	175 ± 38	128 ± 26	93 ± 37	173 ± 53

Clinical groups.—Good:—No organic or pathological condition present; or patients in whom a pathological condition is localized and does not cause any systemic disturbance or abnormalities. Fair:—A moderate but definite systemic disturbance caused either by the condition that is being treated or by other existing pathological processes. Poor:—Severe systemic disturbances from any cause or causes (no fixed criteria)—for example, combination of cardiovascular and respiratory disease that severely impairs normal function. Serious:—Extreme systemic disorders that already threaten life regardless of treatment.

Discussion

Little can be gained by a study of most published reports of prolonged action which have been attributed to suxamethonium; many do not bear critical examination. Following an early warning (Gould, 1952) reports appeared (Harper, 1952; Hewer, 1952; Hurley and Munro, 1952; Love, 1952) in which a prolonged effect apparently followed therapeutic doses. A wide variety of explanations were suggested, although Foldes (1952) thought that the patients were overdosed. Owing to the lack of biochemical evidence it is difficult to dissociate the superadded effects of hyperventilation and of reflex laryngeal apnoea from local stimulation of endotracheal tubes.

A low Ps.ChE. level was found by Bourne (1953) in five patients who had a moderately prolonged action. Further cases were reported (Day, 1952; Grant, 1952; Hodgson and Kothari, 1952; Mackay, 1952; Ruddell, 1952). In none of these cases was a Ps.ChE. estimation available. In the discussion that followed, Durrans (1952) thought that a case had not been made out against suxamethonium as the causative agent in the prolongation of apnoea, and believed that thiopentone was responsible in the majority of cases.

Barron (1952) claimed that large doses of nikethamide terminated the apnoea, but in patients in whom this is due to a low Ps.ChE. level it is difficult to visualize the mechanism involved. It suggests that superadded apnoea from central respiratory depression was present. Nosworthy (1953) stated that blame for unexpected prolongation was often laid on the last drug given, with a failure to distinguish between central and peripheral effects.

There would seem to be little doubt that a pseudo-potentialiation of apnoea can be produced by acapnia, reflex laryngeal stimulus, overstimulation of the Hering-Breuer reflex, central respiratory depression, and other factors not altogether excluded in many of these reports.

The incidence of true prolongation is difficult to establish. It occurs when a low-level Ps.ChE. subject receives a "relative overdose." Early in a personal series of over 2,000 patients to whom suxamethonium had been administered several cases of moderate prolongation of 10 to 15 minutes occurred, but in only two was this time exceeded (Hodges, 1953a). They were confirmed as true "long reactors" having depressed Ps.ChE. levels.

If it is accepted that depressed Ps.ChE. activity is the explanation of most true sensitivity it is salutary that the results of those workers who have examined this activity in health and disease should be studied.

In Health.—Normally the individual Ps.ChE. level remains remarkably constant over long periods, unaffected by physiological changes (Vahlquist, 1935), menstruation (Hall and Lucas, 1937), or seasons of the year (Callaway *et al.*, 1951), though geographic and climatic variations have been suggested (Lackay and Slaughter, 1942; Forbat *et al.*, 1953). Sexes show an even distribution; McArdle (1940) found the levels slightly raised in a small series of children. Organo-phosphorus insecticides and therapeutic radiation (Barnard, 1952) cause a depression, and a fall follows the infusion of albumin (Vorhaus *et al.*, 1950). It may be noted here that suxamethonium when administered to children based on a dose/body-weight relationship, normally adequate in adults, often needs to be supplemented. This apparent tolerance supports the findings of McArdle (1940).

In Disease.—Among pathological states held responsible, hyperpyrexia (Antopol *et al.*, 1937), acute infectious diseases (Hall and Lucas, 1937), cardiac failure, uraemia (McArdle, 1940), and catatonia (Tod and Jones, 1937) were found to depress the Ps.ChE. level, while thyrotoxicosis, diabetes, and anxiety states caused an elevation. In malnutrition (Waterlow, 1950; Hutchinson *et al.*, 1951), in anaemia (Faber, 1943; Scudamore *et al.*, 1951), and in parenchymatous liver disease (Vorhaus *et al.*, 1950) low levels were found in a large percentage of patients.

In the present series the findings did not suggest that such abnormalities existed constantly in the conditions mentioned. Such patients have been anaesthetized on many occasions, using a suxamethonium technique without incident.

Association Between Low Levels and Clinical State

This association has been noted by several observers. Diseases which "essentially affected the general condition" reduced the Ps.ChE. level (Faber, 1943), which level, though it might be used as a critical index of liver function, was of most value when considered in conjunction with the clinical findings (McArdle, 1940). The low levels found in anaemias followed and reflected clinical changes (Scudamore *et al.*, 1951), while in undernourished infants the level rose as their general state improved (Waterlow, 1950). In adult malnutrition the rise due to increased feeding was not related to the increased consumption of any of the major dietetic constituents but rather to a gradual gain in well-being (Hutchinson *et al.*, 1951).

Low levels were found in advanced tuberculosis and carcinomatosis (Vahlquist, 1935; Jones and Stadie, 1939), while Milhorat (1938) found that depression of Ps.ChE. activity occurred in the chronically debilitated state following advanced and toxic processes in a wide variety of conditions; this was not normally characteristic of the diseases when encountered in the early stages. He found that in confined disease with no general manifestations only moderate depression occurred, even in "fatal" illnesses. Milhorat agreed with others (Lucas *et al.*, 1935; McGeorge, 1937) that depression of Ps.ChE. activity could not be related to any particular disease, and Augustinsson (1948) stated that "the mass of data . . . did not allow of any conclusions."

During the present investigation the haemoglobin content was not found to be a reliable guide to Ps.ChE. activity when considered apart from the clinical condition of the patient. Some patients who were in relatively good health

apart from a severe anaemia were found to have normal Ps.ChE. levels, while extremely low values were found in patients with normal haemoglobins.

The association between clinical health and Ps.ChE. activity was very obvious in this study, where a majority of "ill" patients had low levels irrespective of the disease prevailing. The evidence here presented does not justify an arbitrary exclusion *en bloc* from the advantages of suxamethonium treatment, where indicated, of anaemic patients or those suffering from any particular diseases, on the grounds that a low Ps.ChE. level is likely to occur. A more reliable method of estimating this value is a careful clinical assessment, the degree of impairment of clinical health being the overriding factor. In certain apparently normal people the Ps.ChE. may be depressed below normal limits (Davies, 1952; Forbat *et al.*, 1953), though these must be extremely rare. Judging by the response to treatment, no such patient has been encountered in our 2,000 cases.

Seriously ill and debilitated patients are the most likely to show depression of Ps.ChE. activity, but it is in these patients that great benefit is likely to result from the use of suxamethonium. One of us (R. J. H. H.) does not consider that a suspected, or confirmed, subnormal level is any contra-indication to the use of the drug provided that the administration is on a rational basis. Pre-operative clinical assessment, aided if need be by biochemical analysis, together with the use of test doses (Bourne, 1953) and dilute solutions (Bromage, 1953), should reduce the incidence of unexpected difficulty to insignificant proportions. A wider understanding of the factors concerned in depression of Ps.ChE. activity has latterly enabled many anaesthetics on potential "long reactors" to be conducted successfully. The majority of low-level subjects found in this investigation had suxamethonium administered by intravenous drip throughout long procedures. In these subjects complete operations can sometimes be performed safely, using a total dose of the drug that has been advocated as suitable for the induction of paralysis: doses as low as 60 to 100 mg. per hour are not uncommon, though 1,100 mg. per hour has been needed on occasion (Hodges, 1953b) in some normal patients.

The reactions of patients should be judged at the time of administration, a small dose for endotracheal intubation being convenient. Reviewing the synthetic relaxants, Foldes *et al.* (1952) state that suxamethonium "should be the first choice when the use of a muscle relaxant is indicated, especially so in the old or poor-risk patient." We believe this to be so, but due regard must be paid to the sensitivity of these patients. Although forms of prepared Ps.ChE. ("choline") may become available for the resuscitation of patients overdosed, avoiding the necessity for an antidote is a more rational, more satisfactory, and safer procedure.

Summary

Unexpected prolongation of effect following administration of suxamethonium (succinylcholine) is due primarily to a low serum Ps.ChE. An inverse relationship exists between the duration of effect and the individual Ps.ChE. level.

Subnormal Ps.ChE. levels were found in 19% of pre-operative patients; the majority of these low-level patients were clinically "ill."

The reported cases of prolonged action following the use of suxamethonium, and the literature on the variations in Ps.ChE. during health and disease, are reviewed.

No reliable correlation was found between the subnormal levels, anaemia, or any particular disease, but the Ps.ChE. level appears to be a critical index of the general physical state.

The pre-operative assessment of the degree of impairment of general health was the most reliable guide to low Ps.ChE. levels and therefore to the probable suxamethonium sensitivity of the patients.

Neither particular diseases nor subnormal levels *per se* are contraindications to the use of suxamethonium, which is regarded as the drug of choice among the relaxants at present available.

In anaesthesia no dose of suxamethonium can be pre-conceived with certainty. The rational use of dilute solutions allows each patient to be assessed empirically at the time of administration.

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The world's lowest mortality from tuberculosis for the whole of 1953 was recorded in the Netherlands, according to the World Health Organization's *Epidemiological and Vital Statistics Report No. 5* (1954): it was 9.2 deaths per 100,000 population. Denmark was the next most favoured country, with 9.6 for all of 1953, but led the world with the lowest tuberculosis mortality ever registered, i.e., 5.2 per 100,000 population, which was maintained for two months—July and August, 1953. While the Netherlands and Denmark were alone in achieving last year this remarkable position, all of the 25 countries studied in the W.H.O. report have registered considerable gains in the struggle against tuberculosis, and show definite progress over the situation as reported for 1950 in a previous W.H.O. study. These 25 countries, selected from five continents, are the only ones able to provide valid and comparable health statistics, and the situation with regard to tuberculosis is without doubt far from satisfactory in the countries which do not offer reliable statistical information. In fact, even in the group of countries studied by W.H.O., mortality rates from tuberculosis as high as 150 per 100,000 population were recorded in 1953 in some places.

FOOD-POISONING AT SEA

BY

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Passenger ships on long voyages are isolated close communities which are subject to outbreaks of enteritis or gastro-enteritis. As an outbreak is usually under control before the ship arrives at her destination, the port health authorities have no reason to investigate the matter further. The evidence is stale, the data are often insufficient, and the community breaks up as the ship docks. Very rarely is there any publicity.

In some ways a ship at sea makes an ideal experimental group. The crew have free medical attention, and, given confidence in their medical officer, will report sick early, especially with a little advance propaganda. The passengers, bored with their enforced idleness, eagerly seek a new topic for complaint. In fact, there is likely to be almost 100% accuracy in the number of cases recorded. All sources of food and routes of service are easily traced. All the same, unless thorough investigation is made at the outset, trails are lost owing to the complexity of organization.

Epidemic intestinal disease presents gastric or enteric symptoms which may be acutely explosive or so mild as to be little more than a temporary embarrassment. Cases have been described in which the acute explosive vomiting has caused immediate collapse. On the other hand, I have attended patients who have had nothing but a repeated bowel action with only partial control and almost no warning.

On shore it is customary to attack an epidemic with a clear bacteriological picture available. As laboratory facilities are rare at sea the bacteriology is almost always a matter of speculation based on the clinical evidence. In fact, the medical officer must adopt a rationalized version of the purely clinical practice of former years and identify the bacterium or other cause from the symptoms observed.

Catering Services on Board

To understand the channels of infection it is necessary to know something of the layout and organization of the catering services in a large passenger ship: without a clear picture it is not possible to appreciate the reason for certain apparent anomalies in the spread of epidemic conditions.

The ship must be considered as two separate sections: the ship proper, manned by a crew of seamen and engine-room personnel; and, separated by material and disciplinary barriers, the hotel-type organization of cooks and stewards caring for the passengers of one or more classes and for the ship's officers. The ship's company has its own kitchen (or galley), served by a certificated ship's cook and his assistants. Here all food for the crew is prepared from raw provisions, except for bread, cake, puddings, ices, and sweets, all of which come from a single bakery (with a staff of bakers separate from other food preparers), which serves the whole ship with a full range of bakers' products according to the requirements.

The water for all departments is supplied from common storage-tanks, and is potable water passed through filters and pumped up to high-level gravity supply tanks, whence it passes to all the taps in the ship. The water-tanks are filled up at convenient ports: there is no provision for distilling drinking-water on board from sea-water (except