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

for a small emergency apparatus), as the process is much too expensive.

The stewards, cooks, passengers, and officers are fed from one (or more) passenger galleys: all the officers eat with the passengers, except the engineer officers, who have their food served in a separate mess-room. The stewards are also fed in a separate mess-room, though many eat in odd places, often standing to their meals. The cooks may keep back food for themselves in their utensils, though usually they eat special titbits which they prepare according to their fancy.

Provisions for the crew galley and passengers' galley are distributed from common refrigerated meat, fish, and vegetable stores and "dry" store-rooms. The bakery draws its special provisions from the same stores. The galleys prepare meals as far as the sweets: these last come from the baker. The ship's company mess-boys collect their relatively simple fare from the crew galley door: the elaborate passenger menus require special serving-rooms with hot plates and similar devices. These pantries (and stillrooms) are the focal point of the various articles of foods—salads, cold dishes, hot dishes, puddings, ices, cold and hot drinks, fruit, and so on. It is here that they are subject to the maximum handling prior to serving and to much transfer from one dish to another. From here the food and drink are distributed to the passengers and officers, to the engineer officers (via a sub-pantry), and to the stewards.

Washing up is done in the pantries in the passenger accommodation: the crew mess-boys wash up in their messes. There is no refuse problem, as all waste and garbage is thrown overboard at once.

Briefly, then, the ship's crew and the passengers, officers, and their attendants have separate sources of cooked food but a communal bread and water supply: there is no fresh milk on board except for a small stock of sterilized milk provided for infants.

Gastro-enteritis a Familiar Feature

As gastro-enteritis due to food-poisoning is not a notifiable complaint to the port health authority statistics are few. All ship surgeons appear to be familiar with the condition, and it seems to be accepted as a normal feature of ship-board life. Often the condition is mentioned as endemic: indeed, so much is this so that the general attitude is one of resigned vigilance following upon an initial enthusiastic but unsuccessful attack on the first outbreaks. Unfortunately, there is no concise and accurate account of the condition in which the clinical and bacteriological aspects of the question have been co-ordinated with modern practice in public health and naval hygiene.

Royds Jones (1938), describing outbreaks aboard a passenger ship, divided them into three categories: (1) sporadic cases among passengers and crew during a voyage usually on entering or leaving a hot and humid climate; (2) sporadic cases caused by eating ashore; and (3) acute epidemics, often affecting only a section of the community on board.

Details of an Outbreak

An outbreak persisted in a large passenger steamship throughout the passage from Japan to Britain in the winter of 1946-7. There were 52 cases. The ship, with a crew of 300 and some 250 passengers as well as 2,800 troops, travelled from Japan via Shanghai, Hong Kong, Singapore, Bombay, and the Suez Canal to Southampton, and so was exposed to a range of a climate from the bitter cold of continental China to the extremes of equatorial heat in the forty-day voyage.

Members of the steward staff reported with diarrhoea and a temperature of 100° F. (37.8° C.) on the day the ship sailed from Kure, in Japan. As eight men sickened in twenty-four hours it immediately became obvious that an epidemic was threatening and that it was necessary to

isolate the cause before the community on board were overwhelmed.

In investigating the outbreak the following factors were taken into consideration. The issue of bread was common to the whole ship and so was water: these items were therefore not suspect. Ruling out bread and water and issued foods as a cause of the enteritis, there was left the handling of the food and the possible contamination of utensils by washing up: washing-up was not thought to be a factor, as the engineer officers were affected as well as the stewards and five of the passengers. Utensils were washed up in three separate places, so a common link was unlikely. This left attention focused on the pantries where cooked food was handled. Of necessity in catering for large numbers, food is often prepared or part served hours beforehand. Some of the staff are of low intelligence and are often antisocial in that it is difficult to educate them in personal cleanliness and hygienic methods of food-handling.

No laboratory investigations were made, as there were no facilities. All cases of enteritis or gastro-enteritis were treated in their own quarters as the ship's hospital was full of other patients, either invalids on passage or more acute cases which had priority. Only one medical orderly was provided for all duties.

Points in Dealing with an Epidemic

Owing to the general lack of appreciation of the results of preventive measures and the impossibility of securing the full co-operation of a large group of men, many of whom are in their present employment because they are misfits in the community ashore, a "blunderbuss" approach may be necessary. This can be achieved by removing the affected catering staff from duty and giving them energetic treatment designed to stop the diarrhoea in a day, combined with the routine measure of standing the men off duty until they say they want to go back to work, thus appealing to the really sick, who are only too thankful for a chance to lie up. At the same time the opportunity of being off duty attracts those who take the attitude that it is "only a touch of diarrhoea" and who would otherwise carry on with their duties to the risk of those they attend. It is essential that all patients should be given a brief talk on elementary personal and food hygiene before they return to duty.

The following points have to be borne in mind in dealing with a food-poisoning epidemic: (1) The ship has to continue its normal voyage and daily routine. (2) As a matter of commercial industrial practice all steps have to be taken to avoid an epidemic among the passengers, because (a) many would retire to their cabins and expect to be given individual attention, for which there may be no staff available, (b) the ship might run out of essential remedies, and (c) there might be a loss of reputation to the shipping company. (3) Lack of co-operation from men of the equivalent of the foreman group who have spent many years at sea: they do not report sick themselves and do not encourage their juniors to do so. Their attitude may be the biggest obstacle to the carrying out of recommendations with any thoroughness.

The foregoing points show how to treat outbreaks of food-poisoning under normal conditions of passenger accommodation. Similar outbreaks are well known in troopships under purely Service conditions, when thousands of troops may be affected simultaneously, usually by an epidemic enteritis suggesting Sonne dysentery.

Diagnosis

The diagnosis of an outbreak of food-poisoning is best considered by the time factor and the symptoms that arise. If the causes are placed in order of time of onset then they can be presented as follows:

(a) *Metallic poisoning*.—Cadmium, antimony, and arsenic are possible risks, but poisoning with these substances is not associated with pyrexia. The onset is practically immediate in acute cases, and presents a picture of violent

irritation of the gastro-intestinal tract which can persist over a period of days. In addition cadmium causes a form of bronchitis. Such metallic poisoning may be related to the preparation of citrus drinks in plated or enamelled containers.

(b) Staphylococcal or other toxins from the growth of the organism on some article of food contaminated from a septic finger or a boil. The onset is often within an hour and there is an acute gastritis, sometimes with an enteritis. Usually the temperature is not raised, though there are exceptions. This is a single explosive incident unless a food-handler with a lesion on his hands remains undetected to contaminate other foods on another occasion.

(c) Infection by *Salmonella* organisms leads to a gastro-enteritis or enteritis with pyrexia; this occurs some hours after the ingestion of the organisms. Frequently an outbreak of salmonellosis occurs as a result of some single meal, but the continued existence of the organisms depends on some reservoir of infection, and this may be animal or human. Infection of animal origin may spread from the intestinal canal of rats and mice or from the oviduct of fowls, especially ducks. In this connexion the use of bulk liquid egg for catering must not be overlooked. Human spread is from the infected bowel by faecal contamination due to lack of elementary hygienic conduct by a food-handler.

(d) True dysenteries can run a relatively mild course. They have an incubation period of two to five days and present a gastro-enteritis or, more often, an enteritis which is accompanied by a pyrexia. It is to be noted that the types of dysentery vary in frequency and virulence in different parts of the world. For instance, Sonne dysentery is common in Europe but relatively less common in the Far East. The spread is by faecal contamination from the infected human bowel. The excretor may be symptomless and the excretion intermittent.

(e) Typhoid or paratyphoid fever causes a general systemic infection, usually presenting at first as a pyrexia of unknown origin.

Discussion

It would appear that the cases occurring during the outbreak recorded above could have been due to either a variety of *Salmonella* or, most likely, a mild form of dysentery, as the essential features were an enteritis with pyrexia. In view of the persistence of the outbreak the infection must have been from some reservoir of infection, which may well have been a human excretor employed in the handling of the food supplied from the first-class galley. The interesting point is that by standing off duty those food-handlers who were clinically affected it was possible to keep the infection from the group of 250 passengers with only a few exceptions. In the absence of any bacteriological information no other or more accurate explanation of this success can be offered.

In considering the origin of the infection the history is of extreme importance. My cases occurred during a period of weeks. This means that various items of food were infected. It is not possible to think that these several dishes were each carrying an identical infection before handling. The only inference is that they were all infected from some common source during preparation, an interval of a few hours before serving permitting incubation of the organism. This had to be from some reservoir of infection, and under the circumstances this was more likely to be the bowel of a human carrier or case, or alternatively it might have been from the presence of infected mice or rats: in this instance there was no great infestation of the ship with rodents. *Salmonella* organisms frequently persist in the human bowel for weeks or months after an infection which may have been so slight that it could be forgotten or ignored. Such a carrier state in a food-handler is an inherent risk to any community where mass catering has to be provided. There are no certain tests other than stool examinations, and these may have to be repeated in order to deal with the phenomenon of intermittent excretion if there are no bowel

symptoms. These excretors may not infect food if they maintain elementary rules of hygiene and wash their hands after urination or defaecation and on all occasions when restarting work after being away for any other reason.

A careful history and clinical examination will do much to give a reasonably exact diagnosis based on the factors mentioned above. Examination of the menu will often point to an article of food common to all cases. The staff who prepared it must be followed up and their bowel history reviewed.

The alternative diagnoses of epidemic vomiting and Bornholm disease must not be overlooked. The former is epidemic apyrexial vomiting, either as a single act or repetitive with no other symptoms; the latter displays the typical acute abdominal pain which earned it the alternative name of the "devil's grip." These complaints are of the greatest significance, as they are not food-borne, although they present alarming gastro-intestinal symptoms.

A full bacteriological investigation is difficult owing to the impossibility of having a complete set of equipment always available and a medical officer fully trained and alert to use it to its full advantage. The practice of inexperienced and unaccustomed bacteriology is to be deprecated, as false results are worse in every way than no results at all: all that the ship surgeon should do is to use sound judgment in the collection of specimens in appropriate containers under sterile conditions, and to appreciate what are the essential investigations to demand of the laboratory ashore. He must understand the epidemiological aspect of the problem and be able to rationalize his approach. A careful analysis of any outbreak will show clear routes of infection; adequate preventive measures must then be taken. A weak approach leads to confusion, and the subsequent strengthening of precautions can only cause resentment. Strong action can easily be remitted as improved conditions warrant.

It is in dealing with an outbreak such as the one described that the surgeon will really show his administrative skill, although here it must be said that he may be helpless without the full support and collaboration of the captain and other officers, particularly the purser and chief steward. On the one hand, the outbreak must be fully gone into and, on the other, the measures taken must be adequate, relatively simple, and be understood by the staff, who must have induced in them a feeling of personal responsibility in coping with the problem. It causes a glow of respect for some predecessor at sea when an elderly steward confides, reminiscently, "Me and the doctor . . . we fixed it between us!"

It is not possible to comment here on the standards of training in hygiene and epidemiology necessary for those seeking a permanent career at sea in what is one of the most responsible forms of isolated single-handed medical practice. Subject to the overall command of the captain, which at all times must remain unchallenged, it appears to be necessary for the surgeon to have the fullest power to intervene in the conduct of the catering department of the vessel in order to secure appropriate measures for the prevention and control of food-poisoning. Whether this should be done by company regulation or by legislative amendment is immaterial. It is a matter for surprise that the shipping companies do not take more active steps to preserve their reputation in this field.

If the organization of the ship is understood and the places where food is subject to contamination are noted, then it is relatively easy to take steps when an outbreak occurs. The pantries and still-rooms must always be investigated and the previous medical history of the staff recorded. Where there are intestinal symptoms accompanied by pyrexia the infection is by a living organism and a human excretor must always be suspected. A careful and rational approach will indicate the necessary line of action. It is quite possible to deal with the outbreak first and to conduct the laboratory investigation later by preserving specimens by refrigeration.

Summary

The organization of the catering services of a passenger ship is described.

Typical outbreaks of enteritis and gastro-enteritis are mentioned.

Differential diagnoses are discussed with reference to staphylococcal, salmonella, and dysentery infection.

Methods of dealing with an outbreak are outlined.

I wish to acknowledge the encouragement of the chairman and members of the Medical and General Committee of the Association of Sea and Air Port Health Authorities following an address based on a previous article in the *Journal of the Royal Naval Medical Service*. I also had the benefit of the comments of Dr. W. C. Lethem, of the Ministry of Food, Dr. Maurice Williams, medical officer of health, Southampton, and Dr. Morgan, medical officer to the Port of London Health Authority.

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ENTEROCOCCAL ENDOCARDITIS

BY

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In subacute bacterial endocarditis the importance of *Streptococcus viridans* as the causative organism is well recognized. It is not, however, generally appreciated that other bacteria may be involved. Out of 31 cases of streptococcal subacute bacterial endocarditis, Horder (1909) found that eight were due to *Streptococcus faecalis*, and Rantz and Kirby (1943) isolated this organism in 3 out of 16 cases of the disease. However, in large series Sirota *et al.* (1947) and Loewe *et al.* (1951) reported an incidence of the enterococcal variety of 3.2% and 3.8% respectively.

The first case of enterococcal endocarditis was described by MacCallum and Hastings in 1899, the causative organism being the *Micrococcus zymogenes*, now recognized as *Streptococcus zymogenes*. Although several cases have been reported since then, the importance of the enterococci in causing subacute bacterial endocarditis has not been stressed. The following two cases, therefore, are thought worthy of record, constituting only the fifth British report (Andrewes and Horder, 1906; Horder, 1909; Braxton-Hicks, 1912; Cates *et al.*, 1951).

Case 1

First Admission.—A locomotive foreman aged 63 was admitted to hospital on April 30, 1947, with a two-years history of increased frequency of micturition, especially nocturnal, and dysuria without haematuria, culminating in acute retention of urine. His general condition was good. The blood pressure was 165/80, and no abnormalities were recorded in the cardiovascular and respiratory systems. The bladder was distended almost to the umbilicus and the prostate was enlarged, hard, and nodular.

Under general anaesthesia a suprapubic catheterization by the Riches technique was performed, followed by daily bladder lavage. On May 15, under general anaesthesia, a modified Millin prostatectomy was performed; the prostatic capsule was sutured, the bladder was closed with prevesical drainage, and perineal urethrostomy was performed, with subsequent daily lavage. A pyrexia of 100.4° F. (38° C.) on the second post-operative day responded after three days to a full course of sulphadimidine. Convalescence was uneventful apart from a mild thrombophlebitis in the left leg, and he was discharged on June 9. When seen again some weeks later there were no urinary or other symptoms, although he had very slight oedema of the feet and some anaemia

(red blood cells, 3,580,000 per c.mm.; Hb, 69%, or 10 g.); the urine contained albumin, and culture produced a growth of coliform organisms.

Second Admission.—On December 10 he was admitted to the medical department, complaining of malaise, loss of weight, and three attacks of sudden onset, consisting of dyspnoea with palpitations, throbbing headaches, and sweating; each passed off after about half an hour. Examination revealed pallor of the face and mucous membranes, with slight cyanosis, slight clubbing of the fingers, dyspnoea on movement, and evidence of loss of weight. The pulse rate was 90 a minute and collapsing in type. The blood pressure was 188/62. There was no clinical enlargement of the heart. Auscultation revealed a high-pitched musical systolic murmur maximal in the aortic area, and, it was thought at this stage, also an early diastolic murmur. There were no other abnormalities. During most of his time in hospital he had an irregular pyrexia of 99–101° F. (37.2–38.3° C.). Subsequently a definite aortic diastolic murmur became clearly audible. The urine contained a dense cloud of albumin and a moderate amount of deposit consisting of 50–100 pus cells, 10–20 red blood cells, and innumerable motile organisms per high-power microscopical field, while culture yielded a heavy growth of coliform organisms. Several unsuccessful attempts were made to overcome the urinary infection, using various combinations of sulphonamide compounds, potassium citrate, and calcium mandelate.

On January 21, 1948, after ten days' aerobic and anaerobic incubation, blood culture revealed a pure growth of a non-haemolytic *Str. faecalis*. Subsequently he received several blood transfusions, but his condition steadily deteriorated with the development of petechial haemorrhages and oedema of the legs and uraemia. Death occurred on February 8.

Necropsy Findings.—The cause of death was congestive cardiac failure. The heart weighed 720 g. and showed gross dilatation of the right auricle and ventricle and hypertrophy of both ventricles, especially in the left. Subepicardial haemorrhages were present at the junction of the superior vena cava with the auricle. Large vegetations were present on both cusps of the mitral valve, forming a protuberant mass on the aortic cusp, which showed aneurysmal bulging into the auricle. There were also vegetations on the three cusps of the aortic valve and on the wall of the aorta just above the left posterior cusp. The aorta showed a moderate degree of atheroma. At the hilum of the left lung there was an organizing thrombus of a vessel, and the lower lobe contained an infarct. The spleen contained a recent infarct of the upper pole. Small haemorrhages were found in the kidneys, throughout the submucosa of the bladder, and in the subarachnoid space on each superior parietal surface of the brain. The other organs revealed no significant changes.

On histological examination the kidneys showed healed glomerular embolization of a few glomeruli; one glomerulus was observed to contain a mass of bacteria.

Cultures from the heart valves and the spleen yielded a growth of *Str. faecalis*.

Case 2

A primigravida aged 25, who had suffered from rheumatic fever at 12 and 17 years, had a forceps delivery on November 18, 1950. Subsequently she was pyrexial, but after receiving penicillin the temperature settled and she went home three weeks later. On December 25 swelling with intermittent pain and restriction of movement began in the fingers of the right hand, gradually spreading up the forearm to the elbow. The condition lasted for about a week, and subsequently all the larger joints were affected by a wandering polyarthritides. Throughout January, 1951, she felt generally unwell and suffered from night sweats, her temperature often being about 101° F. (38.3° C.). About the end of January a blood culture showed *Str. faecalis*, insensitive to penicillin but sensitive to streptomycin, chloramphenicol, and aureomycin. She was treated with chloramphenicol, 4 g. daily for 14 days, and then, because of the nausea and malaise induced, with streptomycin, 2 g. daily for six days. Her temperature rapidly became normal. On February 18 she complained of a severe headache and her temperature was 99.8° F. (37.7° C.). She was admitted on February 19.

On examination pallor of the skin and mucous membranes and clubbing of the fingers were noted. The blood pressure was 110/60; the pulse rate was 72 a minute, collapsing in type. The apex beat was located in the fifth intercostal space, 5½ in. (14 cm.) from the midline. The cardiac impulse was forcible and heaving. The heart sounds were slapping in character; there were to-and-fro systolic and diastolic murmurs at the aortic area and a rough systolic murmur in all other areas. No other abnormalities were noted.