been 8·1% instead of 5·7%. Fluoroscopic equipment in the ward has improved our capacity to place pacemaker catheters. This equipment may have contributed to the low incidence of primary cardiac arrest, but the reduction in the numbers of early arrhythmic deaths was more probably due to conventional preventive and resuscitative techniques and perhaps to the quiet and restful atmosphere of the ward.

We expected that the presence of monitoring facilities in the subacute section of the ward would decrease the incidence of late arrhythmic death. This may have occurred, but we still had a high incidence of sudden unexpected death during convalescence, usually after monitoring had been discontinued. We had to conclude that results would have been better had we used telemetry to monitor ambulant patients during convalescence or had we been more active in long-term arrhythmia prophylaxis.

Our experience suggests that with longer ECG monitoring and appropriate antiarrhythmic therapy the hospital mortality for myocardial infarction in patients under 65 can be reduced to well under 5%. Mortality may be even further reduced by interventions designed to limit infarct size applied in the very early stage of infarction. Most of our patients who died of late cardiac failure and late arrhythmias had suffered extensive infarction in the early stage of their hospital course. Many were considered for arterial counterpulsation but this was not used because strict criteria for intervention were not met.[13] Measures applied early for limiting infarct size may prevent many of these late deaths.[20]

A detailed costing of the new coronary care cannot be given here. Counterpulsation pumps and catheters together with haemodynamic monitoring facilities have cost about $100 000 over the five years. Fluoroscopy cost another $20 000. Except for the addition of one technologist, medical and ward staff have not been increased with the introduction of these new techniques despite the many extremely ill patients transferred from other hospitals.

We conclude that new advances in coronary care have led to a substantial reduction in hospital mortality. These advances hold the prospect of reducing even further mortality and late disability, and they seem to be justified on economic grounds.

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Referred itch (Mitempfindungen)

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Summary

About one person in four or five is conscious that scratching an irritation may produce an itch elsewhere. The sensation is well localised, comes and goes quickly, and recurs when scratching is repeated a short while later. Scratch and referred itch are ipsilateral; scratching the site of the referred itch does not cause the original spot to itch. Scratching face, palms, or soles does not produce referred itching. Different people stimulated in the same region do not necessarily feel referred itch in the same place. The mechanism of the phenomenon is unknown, though it may be thalamic.

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Introduction

When some people scratch an insect bite they may itch elsewhere. This phenomenon was clearly described by Kovalevsky in 1884.[1] He was professor of physiology in Kazan, but attempts to identify the journal containing his communication have failed. It was, however, summarised by Nawrocki in 1886.[2] Kovalevsky made 21 observations, presumably on himself, and noted most of the chracteristic features. The sensations of the stimulus (which he called the irritation) and the response (*Mitempfindung;* associated feeling) were not identical. They were ipsilateral. The response was limited to a small area of skin, little more than a point. It was quickly elicited and it

quickly subsided. It was reproducible. He also noted some features that subsequent observers have not commented on—that when stimuli were symmetrically applied to opposite sides of the body the responses were not necessarily symmetrical; that the response was usually at a higher segmental level than the stimulus; and that the effect was more easily obtained when the skin was hot and even bathed in sweat.

In 1888 Henry de Fromentel added a further characteristic—namely, that the stimulus was apt to come from inflamed skin. He squeezed an acne pustule to the left of the sternum and felt a sharp pain in the left lumbar region; a *synalgie*, as he called it.[3] Monro[4] described a patient in whom rubbing the back of the right forearm induced pain in the side and front of the right chest. Weir Mitchell wrote: "One of my oldest friends . . . had on one leg a small mole. If this was rubbed or pinched, he had at once a sharp pain in his chin."[5] Sherrington[6] put a mustard leaf over the centre of the upper part of the sternum and felt hot tingling of the inner side of each arm just above the medial condyle.

Sinclair[7] made observations on 18 "trigger points" in four people and noted that the stimulus had to be painful and that it was most effective when the skin was mildly inflamed but that the reaction could be exhausted by repetition. He also commented that the reaction was not reversible: scratching the site of a previous response did not produce any feeling in the site of its stimulus. His observations agreed mainly with those of Kovalevsky, although he seems to have been unaware of them.

Personal observations

I was also unaware of Kovalevsky's work when I started to record my own *Mitempfindungen* in 1940, and of Sinclair's when I made further notes some 15 years later. My findings mostly conformed with those of Kovalevsky and Sinclair, although I did not find the phenomenon invariably reproducible—that is, stimulation of one spot on separate days did not always produce a response in exactly the same place, although it was in the same neighbourhood. Nor did I observe, as Kovalevsky did, asymmetry of response, response at a higher segmental level than the stimulus, or facilitation of response by warmth of skin.

Eventually I had notes of the sites of 158 stimuli and responses. I included a few instances in which there was no scratching—for example, a wasp sting. Furthermore, a simple prick of the pulp of the thumb consistently, or a prick of the pulp of the index or little finger inconstantly, was immediately followed by a pricking feeling in the tongue on the same side. There was no itch; perhaps the tongue never itches.

PREVALENCE

Sinclair[7] found the phenomenon in eight out of 30 young adults. I asked 41 people (23 male, 18 female), "When you scratch a pimple or insect bite have you felt a pricking or itching sensation anywhere else?" Eight at once said they had—six men aged 21-45 years, a 7-year-old girl, and a woman of 23; their average age was 28 years. Those who answered no (aged 17-55 years) had an average age of 30. All but four were nurses, medical secretaries, medical students, or doctors.

STIMULI

Stimuli originated more often from the legs (28 right, 35 left) than the arms (13 right, 31 left), in keeping with the greater skin area of the legs. The left leg was represented a little more often than the right, and the left arm provided over twice as many stimuli as the right (see table; stimuli 2, 3, 4, and 7), possibly because most people are right-handed. Fig 1 shows the distribution of the sites of stimuli. They were found on the skin of any part of the body except palms, soles, face, and scalp. They rarely occurred on ears, forehead, or front of neck but were frequent on the back of the neck up to the external occipital protuberance. Insect bites and infected spots are common on the back of the neck and uncommon on palms and soles, which might explain the differences between these regions but not the exemption of the face.

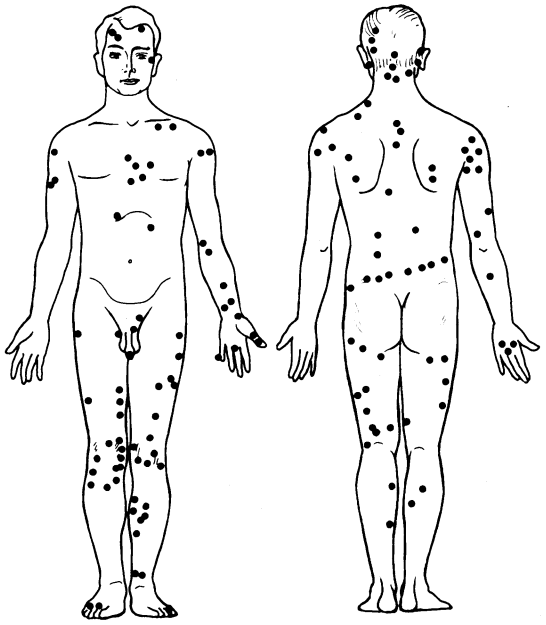

FIG 1—Positions of stimuli.

The symptoms were usually observed casually and recorded only when convenient. At other times they were produced deliberately but not easily. Pinching, scratching, or scrubbing with a stiff tooth-brush occasionally produced paraesthesiae, and pin prick in the injury thus produced sometimes reproduced the paraesthesia, although pricking uninjured skin in the neighbourhood or in the corresponding position on the other side of the body did not do so.

RESPONSE

Often, scratching a spot did not bring a response. When it did, itching was felt as soon as scratching started, persisted as long as scratching continued, and then took some seconds, perhaps a quarter of a minute, to fade out. When the same spot was scratched again soon afterwards the response was repeated, but, as already mentioned, this did not invariably occur if 24 hours had elapsed. Occasionally scratching one spot produced itching in two places, one near the spine and the other anteriorly towards the costal margin. The response to scratching was always on the same side in a point or, more often, a patch 2-3 cm in diameter but sometimes in a patch up to 10 cm long.

The sensation was not pleasant; it was rarely just tickle, and usually unpleasant irritation (itch). It was often painful prickling which then diminished to itch.

The table and fig 2 show the distribution of the paraesthesiae. Most were felt in the paravertebral skin or over the lower chest, and some

Regional relations of stimuli and paraesthesiae

Stimuli		Paraesthesia		
No	Region	Region	Felt in region	Felt elsewhere
1	Head and neck	Chest: T1-8 posterior, T1-6 anterior; neck: C6 laterally	19	1
2	Deltoid and clavicle	Shoulder-tip, triceps, upper chest, and lateral neck	9	2
3	Arm and dorsum of forearm	Chest: T7-10 posterior, T7-8 anterior	14	1
4	Ventral arm and forearm	Chest: T4-8 lateral, T5-8 anterior	13	0
5	Trunk	Chest: T3-12 posterior, T7-9 lateral, T8 anterior	24	0
6	Leg	Chest: T7-9 posterior, T4-9 lateral, T2-8 anterior	63	0
7	Pulp of thumb or finger	Tongue: under surface	5	0
8	Sternum	Chin: under surface	6	1

C = Cervical nerve root. T = Thoracic nerve root.

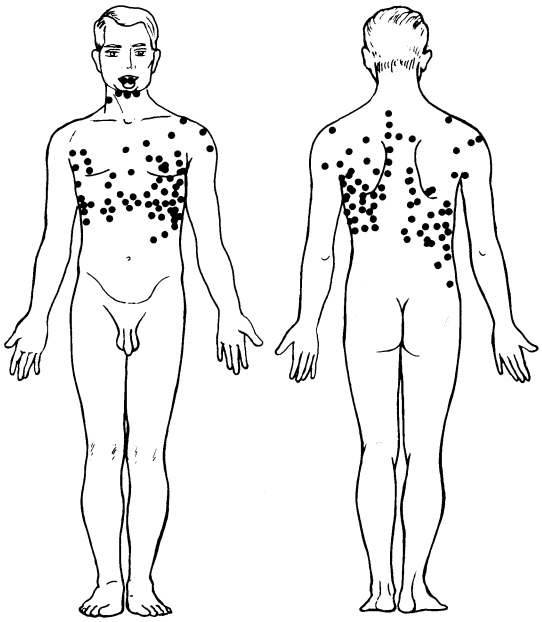

FIG 2—Positions of referred itch.

over the upper chest, with occasional outliers on the neck or upper arm. The special case of the undersurface of the tongue and its relation to the thumb has been mentioned, but there was also another special site in the submental region related to sternal or parasternal scratching from the levels of the second to the fourth costal cartilages.

Responses to stimuli from the legs were felt in the same thoracic area as recorded by Kovalevsky,[1] but he also felt some over the deltoid. In other regions there was discrepancy—for example, stimulation on the forearm was felt by (1) Kovalevsky at the medial border of the scapula; (2) Sinclair[7] at the olecranon and (a separate stimulus) at the seventh intercostal space, half-way between the axillary and nipple lines; (3) Sinclair's subject CW 9·5 cm above the line joining the highest point of the iliac crests, 3·5 cm from the midline; and (4) me (five stimuli and responses) on the anterolateral aspect of the chest in the region of the seventh and eighth intercostal spaces, as in one of Sinclair's responses.

Stimulation over the sternum caused pain in Sherrington's arms[6] and under my chin.

Kovalevsky's responses were felt mainly on the back, especially in the scapular region; in Sinclair's four subjects 10 out of 18 were felt on the chest; in my case all responses to stimulation of the arm, forearm, back of hand, trunk, and lower extremity, and most from the head and neck, were felt on the chest.

With so much variation there seems little point in producing maps of the distribution of responses, for each person would be likely to have his own map, although, as in my case, it might be surprisingly distinct. There may be two reasons for the individual differences—firstly, that the anatomical basis of the phenomenon varies from person to person; and, secondly, that comparison of the scant information available is difficult, especially if it is true, as Kovalevsky reported, that in the most sensitive places irritation of points close to one another may produce responses far apart.

Discussion

The mechanism of production of these sensations is unknown. The branched-axon theory suggests that peripheral sensory axons branch and supply separate areas[8-10]; irritation of one is misinterpreted by the brain as irritation of the other, or irritation of one causes the production of a pain-producing substance by the other. If this is true the ramifications must be enormous—for example, one branch in the foot and the other in the chest.

The occurrence in the chest of so many of the referred itches suggests involvement of the sympathetic nervous system. So, up to a point, does the difference between people in the site of the paraesthesiae, for sympathetic nerves are rather irregularly distributed. One efferent in, say, the third thoracic root (T3) may supply structures somatically supplied by T2 to T10. It is difficult to envisage such a diffuse system providing sensations that are so clearly imagined to be in small and easily localised areas of skin.

After the first synapse, neurites from cells in the dorsal horns cross the spinal cord to the opposite spinothalamic tracts. Crossing is already complete in the segment above the segment of entrance,[11] so the association of widely separated itches cannot occur in the crossing.

Association in the spinothalamic tracts also seems unlikely, for as fibres from dorsal horns are added progressively up the cord one would expect to find an orderly progression of itches: leg would be followed by trunk, trunk by arm, arm by neck, etc. This does not occur—for example, a stimulus in the perineum produces itching on the back above the level of the arm area, and so on.

The somatotopical arrangement is maintained in the lower part of the medulla.[12] In the next stage of running through and relaying in the reticular core there is little spatial arrangement.[13] There might be spread of excitation in the thalamus, where the region for trunk is to be found between the regions supporting sensation from the arms and legs. The region for face (from which stimuli do not produce *Mitempfindungen*) lies separately in the arcuate nucleus. Another possibility of spread occurs in the thalamocortical tracts, and a schema may be composed to explain the association of stimuli and responses, but it demands poor insulation. Professor Sinclair's comment on this is that if there is poor insulation it should work both ways, and in my case stimulation of chest skin should produce responses in the extremities, which does not happen.

The cerebral cortex is another possible site of spread. Sensations may be produced in the trunk and legs by stimulation of the same precentral area.[14] Hand and shoulder areas, although lower and further lateral, overlap the trunk area, and the area for thumb overlaps that for the upper part of the tongue. There is so much overlapping that it is difficult to see how referred itches arising from different parts of the body can be coherently separated in the cortex. These areas were mapped by superimposing results from many patients, however, and there might be less overlapping if only one person were considered. Penfield and Boldrey[14] noted that "the outlines of finger localisation correspond to that of arm, and yet in any individual chart . . . arm will be found above fingers."

The arrangement of sensory regions in the thalamus appears more favourable to the reference of itch from its origin to its paraesthetic location at this point than any other, although a suprathalamic mechanism has not been ruled out.

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