self, and to go on learning for the rest of his professional career. The new curriculum will also allow students to have a certain measure of choice of subjects, so that they may follow alternative paths according to their aptitude and desires. The clinics in the wards will be rearranged to be smaller, and it is hoped that students will take a more personal responsibility for their patients, and have laboratories in which to carry out the simpler investigations on them.

Another aim is to break down the barrier that tends to exist between the preclinical subjects on the one hand and the clinical subjects on the other. It would be wrong of me to prejudge a new curriculum that has not yet been put into operation, but I hope that the clinical importance of preclinical subjects will be stressed at an early stage in the course, though I agree with the view that the encouragement of critical habits of thought should be an objective of the teaching in the preclinical period. I am sorry that pharmacology is to be made a preclinical subject and that the happy union of pharmacology and therapeutics in fourth-year teaching has been dissolved. I hope, too, that the departments of pathology and bacteriology, now shown in the new draft programme as doing their teaching in the fourth year, will continue to provide instruction in the general aspects of pathology and bacteriology in the third year. To the clinician it is most important that this should come before the students are given their basic instruction in the examination of the patient, a very important part of the course that will in future be taught in the period that is now the vacation between the third and fourth years. I may add in passing that the problems of pre-clinical teaching are likely to increase in the future if inadequate salaries in preclinical university departments throughout the country continues to lead to an almost complete lack of applicants with medical qualifications for vacant teaching-posts.

The teaching of postgraduate students is as much the concern of the Royal Colleges and Corporations as of the Universities, and the four Scottish Universities have formed a Postgraduate Federation to plan courses and prevent overlapping. The Royal College of Physicians of Edinburgh is going from strength to strength and there are great developments under way in the Royal Faculty of Physicians and Surgeons of Glasgow. It does seem, however, that in this small country that has given so much to Medicine it is wasteful to have what are in effect two powerful Colleges of Physicians carrying out similar functions. When the dust has cleared and the Edinburgh and Glasgow Colleges have completed their current plans for development, I wonder whether the time has not come to re-examine the possibility of uniting to form a Royal College of Physicians of Scotland. Such a College might be in a position to contribute significantly to medical education in the Commonwealth.

Such is unity, and unity is all-important. In universities, medical schools, and colleges there are always problems of personalities and of conflicting aims and ambitions. In many university towns there is rivalry between the members of the university staff and those of their colleagues who are employed under the National Health Service. Let us have the stimulus of friendly rivalry and competition. We have great opportunities. The medical school is at a critical phase of expansion and development. There is so much to be done. Let us not waste our energies by deviating

from the common purpose to indulge in internecine pyrotechnics.

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NOTES ON CARDIAC RESUSCITATION, INCLUDING EXTERNAL CARDIAC MASSAGE

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Beck *et al.* (1956) wrote: "This is the report of a man who died from a heart attack and in whom defibrillation was successfully accomplished. He was dressed in his street clothes when death and resuscitation occurred." Their dramatic account showed the possibility of reviving the victims of cardiac arrest outside the operating-theatre, and was followed by further reports of successful resuscitation by thoracotomy and direct cardiac massage (Reagan *et al.*, 1956; Celio, 1956; Walton, 1960; Straight *et al.*, 1961; Brass and Kendell, 1961). The introduction of external cardiac massage by Kouwenhoven *et al.* (1960) has now given a further impetus to attempts at the rescue of medical patients. In the past two years accounts have appeared which leave no doubt of its efficacy (Gazes and Boone, 1961; Jude *et al.*, 1961a; Nixon, 1961; Thal *et al.*, 1961; Hardy, 1962; Semple and Dall, 1962), while others have also pointed out its complications (Baringer *et al.*, 1961; Morgan, 1961).

Although external cardiac massage may enable an adequate circulation to be maintained during the period of arrest (whether the mechanism is ventricular standstill or fibrillation), a spontaneous return of heart action cannot be relied on, and the adoption of the method requires familiarity with its two chief adjuncts, the external cardiac pacemaker and the external defibrillator. In this field the contribution of Zoll and colleagues has been paramount (Zoll, 1952; Zoll *et al.*, 1955, 1956). The first use of an external pacemaker made in this hospital was reported by Leatham *et al.* (1956), and since then its value has been repeatedly proved, especially in the treatment of Stokes-Adams attacks. External defibrillation, with electrodes applied to the intact chest wall, was used with success in dogs by Hooker *et al.* (1933) and Guyton and Satterfield (1951), and has now become an established clinical practice (Zoll *et al.*, 1956; Kouwenhoven *et al.*, 1957). Our own experience of it is more recent.

We believe that the triad of external massage, external pacing, and external defibrillation (with thoracotomy and direct defibrillation in reserve) will become accepted practice in all hospitals once the necessary apparatus is

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available. At present few centres in this country are suitably equipped, and it is paradoxically the teaching hospitals with specialist cardiac units that are best off, whereas some of the busy peripheral hospitals with a greater number of emergencies have been neglected. The purpose of this paper is to set out the instructions for cardiac arrest now in force in this hospital and to summarize our recent experience. We deal here only with "medical" cardiac arrest and have excluded those cases occurring in the operating-theatre or after operation. The control of recurrent Stokes-Adams attacks is described in a separate communication (Portal *et al.*, 1962).

Equipment

Our present equipment is not elaborate and represents the minimum which is necessary. There is ample room for ingenuity in the design of composite instruments such as an electrocardiograph oscilloscope and direct writer, or a combined electrocardiograph, pacemaker, and defibrillator, but we are not convinced that they would produce better results than the simpler apparatus. The human element is more important, and if resuscitation fails where it should have succeeded delayed or incorrect application of the procedure is more likely to be responsible than any shortcoming of the equipment.

E.C.G. Oscilloscope

Though this is a familiar instrument in the operating-theatre, we believe its value has not been sufficiently appreciated in the casualty department and wards. Its immediate attachment to the collapsed patient provides a continuous display of the cardiac rhythm, visible to all, including those who are engaged in resuscitation. It avoids the need to operate the standard E.C.G. machine or to strain to scrutinize the issuing paper. A permanent tracing may be obtained in some models by plugging the electrocardiograph recorder into it.

External Cardiac Pacemaker

There are several suitable pacemakers on the market. The instrument used in this hospital was designed and built by one of us (J.G.D.)* and has been fully described in an earlier paper (Leatham *et al.*, 1956). The pulse is of condenser discharge type, duration approximately 4 milliseconds, with a voltage variable from 0 to 200 and rate from 30 to 120. It may be worked either off the mains or from its own self-contained battery. At present we use two ordinary E.C.G. electrodes which are applied to the chest wall, one at the left sternal edge in the fourth intercostal space, the other in the midaxillary line at the same level. The operator insulates himself with rubber gloves. Shocks are delivered at a rate of 60 to 70 per minute. In an unconscious patient it is as well to use the maximum voltage, reducing this to the threshold if continued stimulation is needed on recovery. We have found that if the electrodes are well lubricated with E.C.G. jelly and correctly placed a ventricular contraction may be produced in a patient of average size at about 70 volts. An analgesic will be required to dull the pain of the shock, and intravenous pethidine has proved very suitable.

The pacemaker will be effective under two conditions: (1) the ventricles must be in asystole (or beating slowly) at the time of stimulation; no response can be expected if the rhythm is ventricular tachycardia or fibrillation;

*Subsequently built by Firth Cleveland, Ltd., and marketed by Sierex, Ltd.

and (2) the myocardium must be capable of an effective mechanical response. The presence of an electrical response to the stimulus, manifest by T waves on the E.C.G., is not evidence of an effective ventricular contraction, which can be gauged only by the production of good peripheral pulses and the patient's clinical response. (It should be remembered that the magnitude of the T wave varies with the lead used, so that two or three leads should be tried before concluding that a ventricular complex is absent.) If the myocardium is damaged or anoxic, an adequate circulation is more likely to be achieved by external cardiac massage than by a weak stimulated contraction.

External Defibrillator

The instrument in use has been described in detail elsewhere (Perry and Trotman, 1958). It was designed as an internal A.C. defibrillator capable of delivering 350 volts for a period of 0.2 second, but for external use a step-up transformer has been included in the output. This enables a shock up to 750 volts to be delivered. The electrodes measure 8 cm. in diameter and are covered with gauze, which must be soaked in saline and E.C.G. jelly to improve the electrical contact. Certain electrode positions have been recommended so as to pass current through either the long or the horizontal axis of the heart; in the first case one is placed on the suprasternal notch and the other in the left mid-clavicular line at the level of the xiphoid (Kouwenhoven *et al.*, 1957); in the second the positions are the anterior axillary line and the left sternal edge, both at the level of the apex (Zoll *et al.*, 1956). Other axes have also been successful in our experience. For safety the instrument is designed so that no current will pass unless both a hand-button and a foot-switch are simultaneously depressed. If a single shock is ineffective, from three to six consecutive shocks are given at 2-second intervals, for there is evidence that this increases the chances of successful defibrillation (Wiggers, 1940). Direct current defibrillation may in the future prove more effective. The oscilloscope trace is studied after each series of shocks, and if fibrillation persists a period of massage is given before the attempt is repeated. A coarsening of the fibrillation pattern is an encouraging sign.

Apparatus for Maintaining Ventilation

The Portex "resuscitube" is probably the simplest airway for emergency use and enables "mouth-to-mouth" respiration to be carried out without direct contact with the patient. The Ambu resuscitator is convenient for manual inflation and may be used with a mask or endotracheal tube. Intubation is clearly the best method of ensuring an airway and should be performed as soon as possible after collapse. This technique might be more widely taught. If unskilled intubation proves difficult, time should not be lost and a temporary pharyngeal airway should be inserted.

Instructions for Cardiac Arrest

Signs of Cardiac Arrest.—(1) Unconscious patient. (2) No pulse in major vessels (carotid best). (3) No heart sounds. (4) No improvement after lying flat (to exclude a simple faint). Unless the cerebral circulation is restored within three minutes the patient will die or suffer irreversible brain damage.

Start External Cardiac Massage.—(1) Place the patient flat on his back on a hard surface (the floor is best). (2) Press sharply about 60 times a minute with both

hands over the lower third of the sternum to compress the heart between sternum and spine.

Maintain the Airway.—Clear the mouth, hold the jaw forwards, and apply mouth-to-mouth respiration (by means of resuscitation airway if available). Restarting the circulation, however, is more urgent than supplying oxygen.

Send for: (1) E.C.G. machine for diagnosis of rhythm. (2) Another doctor, preferably an anaesthetist, to pass endotracheal tube and give oxygen. (3) External stimulator and defibrillator.

Effective external massage will be shown by absence of dilated pupils, return of normal colour, and usually the presence of a pulse with the artificial beat. There is then no great hurry and advice can be sought.

The E.C.G. will show: (1) *Ventricular Standstill.* (There may or may not be P waves, but there is no QRS complex.) This may respond to the external cardiac pacemaker. Apply E.C.G. jelly and the two electrodes

over the praecordium and deliver 200-volt impulses 60 times a minute. If after 10 shocks no clinical improvement is noted or femoral pulses are not readily felt, stop stimulating and continue external massage. Or (2) *Ventricular Fibrillation.* This will require the more specialized and dangerous technique of external electrical defibrillation and application of the pacemaker will be useless. Should external defibrillation fail, the aim should be to transfer the patient to the theatre for thoracotomy and internal defibrillation. Closed chest massage must be continued during transit and up to the moment of thoracotomy.

Experience

In the past 18 months external cardiac massage has been attempted in 18 patients. The details are summarized in the Table. Only three survived: two of them (Cases 5 and 17) were patients with complete heart-block in whom massage was employed after loss of consciousness from rapid ventricular tachycardia. In

Attempts at Cardiac Resuscitation

Case No.	Sex and Age	History	Interval between Collapse and Massage	E.C.G.	Result of External Pacemaker	Result of External Defibrillator	Duration of Massage	Outcome	P.M.
1	F 2½	Aortic stenosis. Coarctation of aorta. Cardiac failure	3 mins.	—	—	—	30 mins.	Died. Spontaneous ventricular action restored for 60 mins., then V.F.	Aortic stenosis. Coarctation of aorta. Left S.V.C. Anomalous origin right subclavian artery
2	F 56	Barbiturate over-dosage; blocked endotracheal tube	½ min.	—	—	—	1 min.	Survived (normal)	—
3	F 69	Digitalis intoxication. Gross failure. Stuporous	2-3 mins.	V.F.	—	Failed	30 mins.	Died 6 hours after thoracotomy and internal defibrillation	Large heart. No valve or coronary disease. Presumed cardiomyopathy
4	M 9 mths	Suffocation by bed-clothes	?	No activity	—	—	25 "	Died	—
5	F 66	Stokes-Adams disease. No failure	Immed.	Rapid ventricular tachycardia	—	—	2-3 mins. (on 3 occasions)	Survived	—
6	M 79	Complete A.-V. block. Cardiac failure	3-4 mins.	V.F.	No response	Successful after procainamide	?	Died	Large heart. No infarct
7	M 57	Old infarct. Cardiac failure	½ min.	V.F.	—	Successful after procainamide but V.F. recurred	50 mins.	"	—
8	F 60	Recent failure following infarct. Mild A.S.	Immed.	Asystole	No response at first, then provoked V.F.	—	50 "	"	—
9	F 64	Acute infarct	? 5-10 mins.	V.F.	Good response after defibrillation	Successful. Recurrence of V.F. Successful again	30 "	Died 5 hours later	Fibrin thrombus in right coronary. Patchy narrowing of rest of tree
10	M 54	Old infarct. Acute infarct	1 min.	? initially then V.F.	No response	Successful	160 "	Died (S.R. restored, then lucid interval with speech, then V.F.)	Old posterior infarct. Recent anterior infarct
11	F 22	Chronic bronchitis and asthma. Admitted in acute respiratory failure	? mins.	Asystole	No pulse produced	—	58 "	Died. Effective heart action restored but no recovery of consciousness. Further arrest next day	Heart enlarged and dilated
12	M 58	Aortic stenosis and recent infarct	? 12 mins.	V.F.	No response noted	Successful but recurred twice	53 mins.	Died	Aortic stenosis. Recent infarct
13	M 10 mths	Cyanotic congen. heart disease. Recent failure	?	Asystole	—	—	?	"	Pulmonary stenosis. V.S.D. P.D.A.
14	M 52	Old infarct. Acute infarct	? 2 mins.	V.F.	—	Failed, but spontaneous return to S.R. after procainamide	30 mins.	Died after thoracotomy and attempted coronary perfusion	—
15	F 74	Brought to casualty collapsed. Presumed infarct	?	Asystole	No response	—	75 "	Died	Advanced atheroma of coronary arteries. Left descending branch nearly blocked at 3 cm.
16	M 59	Aortic valve and coronary artery disease. Paroxysmal tachycardia	Immed.	V.F.	—	Failed	40 "	"	—
17	F 28	Stokes-Adams disease. No failure	"	Rapid ventricular tachycardia then asystole	Good response	—	1 min.	Survived	—
18	M 44	Acute infarct	½ min.	V.F.	No response	—	20 mins.	Died	—

V.F. = Ventricular fibrillation.

both cases the period of massage was short and recovery from earlier episodes suggests that a spontaneous return of effective heart action might have occurred. Cardiac arrest in the third survivor (Case 2), unconscious from barbiturate overdosage, was caused by an obstructed endotracheal tube; recovery was complete. Apart from these patients, spontaneous ventricular action was temporarily restored in four others. The first, a small child (Case 1), resumed a ventricular rate of 60 to 70 for about an hour before relapsing into fibrillation; the second (Case 10) recovered consciousness for a few minutes but fibrillated again; the third (Case 9) developed a ventricular rate of 40 and survived five hours with the aid of artificial pacing, but without regaining consciousness; the last (Case 11) also remained unconscious but survived 27 hours, only to succumb to a further arrest.

External defibrillation was attempted in eight of the nine patients in whom ventricular fibrillation was confirmed by the E.C.G. and was successful in five, though relapses occurred and none of them eventually recovered. The external pacemaker was used in nine patients; in two a good myocardial response was produced, in one it appeared to trigger off ventricular fibrillation, while in the remainder it was without effect. It has, however, been almost invariably successful in the treatment of asystole due to Stokes-Adams attacks or digitalis or quinidine poisoning. In these cases, excluded from the above series because closed-chest massage was not necessary, the important factors were speed of application of the pacemaker, which was held in readiness at the bedside, and a good myocardium. Zoll *et al.* (1955) reported similar success in this group.

Comments

On our experience so far in these few cases we base the following comments.

External massage, though easier, less dangerous, and requiring less equipment than direct massage, can be tiring and difficult to maintain with comfort for more than 15 minutes, and a change of operator before this time is desirable. There may be a place for a mechanical device for external massage provided the force exerted can be adjusted to the build of the patient; such an apparatus has been described by Rand and Beck (1961). It would seem to be of most value when attached to a trolley.

Despite its obvious disadvantages we have found the floor the best surface on which to carry out the procedure. Its firmness allows the operator an exact assessment of the amount of sternal movement he is producing, and his position as he kneels beside the patient gives him the greatest mechanical advantage. Fracture boards on the bed are the second choice.

The jerk imparted to the whole body by the compression makes it difficult to feel the peripheral pulses. An apparently good pulse was once felt in a femoral artery known to be pulseless owing to occlusion before the cardiac arrest. This was presumably due to transmission of intra-abdominal pressure into the femoral canal or to the production of a venous pulse. Even the carotids can be difficult to assess. We feel, therefore, that claims of "excellent pulses" made by enthusiastic assistants may be unreliable, and that it is better to gauge the patient's response by his colour, the size of his pupils, and his state of consciousness than by attempts to judge pulses or measure blood-pressure. Fuisz *et al.* (1961) have made the same observation, and Weale and Rothwell-Jackson (1962) have emphasized, in the light

of experiments on external massage in dogs, that an arterial pressure pulse is not necessarily evidence of perfusion of an organ.

On two occasions loss of consciousness was immediately followed by a period of generalized tonic spasm lasting many seconds which made movement of the chest by external compression virtually impossible. There seems to be no way of avoiding this delay in restarting the circulation.

In cases of asystole we emphasize again the importance of not persisting with use of the external pacemaker unless there is good evidence of an adequate circulation. Contraction of the thoracic or upper-limb muscles inevitably accompanies the shock, but, in contrast to massage, does not prevent reliable assessment of the pulses. Valuable time may be wasted by unwarranted reliance on the pacemaker when dealing with a damaged heart from which a better output may be obtained by continued massage.

We find it difficult to make rules about the use of drugs in cardiac arrest, and have no set routine. The intravenous administration of digitalis is probably inadvisable, but adrenaline in small doses assists in increasing myocardial tone and may not predispose to ventricular fibrillation. Intracardiac injections were long ago (Hyman, 1932) considered effective only by virtue of the mechanical stimulus, and thumping on the chest (Scherf and Bornemann, 1960) serves the same purpose. Furthermore, intracardiac injections not infrequently lead to haemopericardium. We have no experience of the use of calcium in these emergencies, and little of drugs to counter acidosis such as infusions of sodium lactate or bicarbonate; a limited experience of sodium lactate was not encouraging.

Procainamide was given intravenously in three cases: in two of them electric defibrillation was then successful although it had failed before; in the third, spontaneous termination of fibrillation occurred when massage was restarted. Though it is impossible to base any conclusions on these few observations, experimental work in dogs has shown that after procainamide ventricular fibrillation is less readily induced and more easily stopped by an appropriate electrical stimulus (Herrod *et al.*, 1952). Procaine injected direct into the heart has been used from the early days of cardiac resuscitation in the operating-theatre (Beck, 1941), and Walton (1960) reported the termination of fibrillation in his patient after an intravenous injection. Julian (1961) electrically defibrillated a patient after intravenous procainamide when numerous earlier attempts had failed. We therefore feel that this may prove a useful agent in cases of fibrillation, but would recommend small doses of not more than 200 or 300 mg.; for procaine is a myocardial depressant which may reduce the power of ventricular contraction. Furthermore, the myocardium needs oxygen more than any drug.

When defibrillation failed at the first attempt it was frequently successful later, even at the fourth or fifth application. Perseverance is therefore worth while, and the chances of success will be enhanced by the improved myocardial oxygenation provided by effective massage and artificial respiration. It has indeed proved possible to terminate ventricular fibrillation by external massage and artificial respiration alone, without recourse to the defibrillator (Semple and Dall, 1962; Wetherill and Nixon, 1962).

The presence of significant valve disease, particularly aortic stenosis, would be expected greatly to increase

the difficulty of resuscitation, and might well make it impossible to produce an adequate circulation by external massage. Such patients would almost certainly derive little benefit from internal massage. When performing cardiac catheterization on such patients we ensure that external stimulation or defibrillation can be started on the instant of arrest, before the myocardium becomes anoxic.

We have not so far encountered any serious complication of massage nor had any reason to regret its use. Though ribs have been broken, especially in the early cases, no damage to thoracic or abdominal viscera was found in the nine cases that came to necropsy. In two cases bone-marrow emboli were seen in the lungs, a finding already reported by Baringer *et al.* (1961) and Winkel and Brown (1961). Judgment is best reserved on whether this could give rise to serious sequelae in a patient who survived.

The important question of ventilation demands some comment. It has been shown by Safar *et al.* (1961) that external massage performed on anaesthetized curarized subjects fails to produce an adequate tidal exchange even with endotracheal intubation. In a small number of similar experiments of our own in five healthy young subjects mean tidal volumes ranging between 83 and 267 ml. were produced with a conventional airway and head tilted back, and values between 115 and 325 ml. when an endotracheal tube was inserted. Safar *et al.* report that in 12 cases of cardiac arrest "essentially no ventilation" was measured during massage. Since a large proportion of the victims of arrest are elderly patients with a rigid chest and perhaps pulmonary disease in addition, it is clear that sternal compression cannot be relied on to provide useful ventilation. We therefore recommend intubation and inflation with oxygen or air as early as possible; initially, mouth-to-mouth insufflation may be the only method available, and this is made a great deal easier by a liberal provision of resuscitation airways in wards and casualty department. When the operator is single-handed, however, he should concentrate on massage, for oxygenated blood will be present in the arrested pulmonary circulation unless anoxia was the cause of the arrest, and in many cases a few spontaneous inspirations will occur after loss of consciousness.

Discussion and Conclusions

Attempts at resuscitation in "medical" cardiac arrest are inevitably disappointing and form a sad contrast with the results obtained in surgical practice. This is well illustrated by the report of Jude *et al.* (1961b) on their experience of external massage in 138 arrests occurring in 118 patients. In 31 patients the arrest took place in the operating-theatre or recovery-room, and 20 survived to leave hospital; in the remaining 87, consisting of patients admitted for cardiac surgery or myocardial infarction and a large miscellaneous group, only eight left hospital. The authors pointed out, however, that in their total of 138 arrests the heart was restarted in 78%. One would expect the subjects of our present report to form a category with a similar prognosis to Jude's non-operating-theatre groups, and this is certainly the case, our results simply serving to illustrate the difficulty of reviving hearts that are seriously damaged by infarction, valve disease, or other causes. Apart from the two patients with Stokes-Adams disease, only one survived, and she was the only one with a healthy heart.

It is evident that the chance of resuscitation is small when the patient is already in hospital for serious cardiac or respiratory disease, unless the arrest occurs during a procedure such as cardiac catheterization, or as a result of drug intoxication or disease of the conducting tissue. Patients who are in a terminal illness, so that attempts at resuscitation would be unjustified, are usually known to the ward medical and nursing staff, and the possibility of success in an emergency may even have been discussed on a ward round beforehand. In many cases, however, we believe that external massage must be started if only to give time for a proper decision by those acquainted with the underlying disease; a useful guide in such cases will of course be the patient's initial response to massage. Indeed, the more the routine of resuscitation is performed the greater the likelihood that the correct procedure will be carried out in a patient with a good prognosis. Thoracotomy and internal cardiac massage have in our opinion been superseded in most cases by the closed-chest technique. Both patients in whom a thoracotomy was later performed eventually succumbed, and it is extremely difficult to believe that any of the others could have benefited by this measure. If external defibrillation fails and the circumstances still warrant a thoracotomy for internal defibrillation, it should probably be carried out under sterile conditions in the theatre; the continuation of external massage will allow time for the necessary preparations to be made.

The achievement of external defibrillation in five out of the eight patients in whom it was attempted confirms the practicability of the method and suggests that more survivors would be obtained in less extreme cases, as is borne out by the large experience of Jude *et al.* (1961b). The defibrillator is a potentially dangerous instrument, however, and should not be used by unskilled operators.

In contrast with the excellent results from the external pacemaker in Stokes-Adams disease, we have found this instrument of limited value in asystolic arrest not due to heart-block or drugs. External cardiac pacing is only likely to be successful when the myocardium is capable of contraction but lacks an intrinsic pacemaker; pacing will not be successful if the myocardium has become unresponsive from prolonged anoxia.

Summary

The treatment of cardiac arrest by external massage, external pacing, and external defibrillation is discussed with emphasis on simplicity of the plan of action to reduce delay, and the minimum apparatus required. The instructions for cardiac arrest now displayed for the guidance of the staff in the St. George's Hospital group are quoted.

Of 18 cases treated by external massage, with or without electrical aids, only three survived. In four others spontaneous ventricular action was temporarily restored. External defibrillation was attempted in eight patients and was successful in five, though none of these eventually survived. External pacing was employed in nine patients, but produced an adequate myocardial response in only two. These poor results are in striking contrast to the excellent results obtained by electrical resuscitation in patients with recurrent Stokes-Adams attacks.

Our experience, in agreement with others and with theoretical expectations, is that success is likely only when the arrest is primarily due to disease of the

conducting tissue or to a transient disturbance in a healthy heart.

Many others have contributed to our experience of resuscitation and we are grateful to them and also to Dr. D. D. C. Howat for experiments in ventilation. We are grateful to the Medical Committee of St. George's Hospital and the Editor of the *Proceedings of the Royal Society of Medicine* for permission to reproduce the instructions for cardiac arrest.

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ADDENDUM.—Two further experiences, outside the consecutive series of cases described, serve to illustrate the importance of external massage. A woman aged 55 came to the casualty department complaining of chest pain and collapsed from ventricular fibrillation. External massage was required for 20 minutes before defibrillation was achieved, and she subsequently made a complete recovery and has returned home free of symptoms; the electrocardiogram showed changes of cardiac infarction limited to the diaphragmatic wall. In another woman, aged 61, with heart-block and ventricular fibrillation, external massage had to be continued for over an hour until procainamide restored normal rhythm. Tracheostomy was required owing to multiple rib fractures, but she made a complete recovery and is now living a fairly normal life with the aid of an artificial pacemaker.

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VACCINATION IN INFANCY WITH ORAL POLIOMYELITIS VACCINE AND DIPHTHERIA, TETANUS, PERTUSSIS VACCINE

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Infant immunization against poliomyelitis, diphtheria, tetanus, and pertussis has been recommended by the Ministry of Health, using either inactivated poliovaccine (*Brit. med. J.*, 1961) or oral poliovaccine (M.O.H. Circular 3/62). Three doses of triple vaccine (diphtheria, tetanus, and pertussis) and three doses of poliovaccine are given at separate attendances, the complete schedule entailing six visits to a clinic. These visits could be reduced to three if oral poliovaccine were administered at the same time as triple vaccine. Reports from Hungary (Kelemen *et al.*, 1961) have already indicated that such a procedure is likely to be effective. However, so far there has been no information from British sources of the effectiveness of oral poliovaccine in infants under 6 months of age, either alone or in combination with triple vaccine. The effectiveness of inactivated poliovaccine in early infancy is materially reduced by interference by maternally transmitted antibodies, and the extent to which the oral vaccine can overcome such interference is important if the vaccine is to be employed in early infancy.

The studies described here form the first of a series to be carried out at University College Hospital and Guy's Hospital, London, and at the Swindon Public Health Department to determine the effectiveness in early infancy of oral poliovaccine and triple vaccine given simultaneously.

Procedure

The participants in this study were healthy infants attending for routine primary immunization at the infant welfare departments of University College Hospital (group 1) and Guy's Hospital (group 2). Pre-vaccination serum samples were obtained from all infants at their first attendance. One ml. of poliovaccine was administered orally from a syringe. The triple vaccine was given