cause for it is to be sought in some complication to which appropriate treatment must be directed.

In addition to the general cares above outlined, special care will be required for the management of the wound, of the trachea, and of the cannula.

THE WOUND.—In general, the cares which the wound will demand are very simple; while it remains open, its secretions, together with any tracheal secretions that are ejected upon it, readily flow away. No dressing should ever be applied which would favor the retention of secretions in the wound. Twice daily, the wound should be lightly dusted with iodoform or bismuth to prevent septic changes, while the wound, as a whole, should be kept protected from external irritation by a small square of linen or similar material laid over it, smeared with an emollient, like the salicylated zinc ointment, already mentioned. The removal of dried crusts and the general cleanliness of the adjacent parts must be looked after on general principles. After the cannula has been dispensed with, the wound rapidly contracts, the cannula fistula collapses, its walls quickly adhere, and a simple superficial granulating surface is left, the treatment of which is conducted on general principles. The rapidity with which these reparative changes take place will depend on the amount of the previous disturbance of the wound and on the general vigor of the patient. When much loss of substance has taken place, or the cannula has been worn for a long time so that its sinus has become lined by a well-organized membrane, a permanent fistula may remain, the obliteration of which may require a plastic operation.

Phlegmon of the Wound.—Some phlegmonous inflammation of the borders of the wound is common. They become tumefied and indurated, and a zone of redness extends to a variable extent outward upon the skin of the neck, and downward upon the thorax. Little tendency seems to exist to the formation of abscesses—at least I have never observed it; the necrotic changes which it determines in its more intense forms take place on the surface, and may range from slight ulceration to extensive sloughing. If erysipelas or diphtheria is engrafted upon it, these necrotic changes will be aggravated. This wound inflammation is septic in character, and aggravated by the irritation of the cannula. It begins to manifest itself more especially during the third day; if life is prolonged and the case does well in other respects, it will begin to subside after three or four days, especially if the cannula can be dispensed with. An efficient antiseptic treatment of the wound from the first, as already advised, is the best preventive of this phlegmonous invasion, and the best curative, if the invasion has already taken place. The inflamed integument should be kept anointed with carbolated oil (carbolic acid, three per cent.), or an ointment of ichthyol (ichthyol or ichthyolate of ammonia, ten per cent.). The cannula should be kept out of the wound as much as possible. Even though the condition of the larynx may not permit of the permanent removal of the cannula, still the stiffness of the wound borders will suffice to keep the track of the cannula patent enough for respiration for quite a while after the tube has been taken out, so that the patient may be able to get along without the latter for from fifteen to sixty minutes or more at a time, before it becomes necessary to replace it. After the tube has been in place for an hour, it may be removed again, and so on as long as the persistent wound inflammation may require such help. In such cases as this the use of a suitable obturator to facilitate the reintroduction of the tube (see Fig. 4743) is especially needed. With the help of such an obturator any intelligent nurse can carry out this procedure. Erysipelas of the wound is characterized by a more extreme spreading of the skin inflammation, is simply a more severe form of septic disturbance of the wound, and is to be antagonized by the same kind of treatment.

Diphtheria of the wound demands no special treatment different from that given to the phlegmonous inflammation which attends it. If the case does well in other respects, the exudate exfoliates spontaneously in due time, and cicatrization proceeds.

Gangrene of the Wound.—This may manifest itself either in a progressive ulcerative process that converts the wound into an ill-conditioned spreading ulcer, or in the formation of distinct sloughs of necrosed tissue. Its causes are the same as those of the less severe forms of septic infection already noted, and indicate a more intense form of infection and less local and general resisting power on the part of the patient. A black discoloration of the cannula, caused by the disengagement of sulphureted hydrogen, indicates the beginning of the gangrenous process. The treatment consists in the use of local stimulants and antiseptics, and general tonics, and the suppression of the cannula as much as possible. If the gangrene is superficial, the sloughs are soon cast off, the wound assumes a healthy appearance, and its cicatrization proceeds without any permanent damage having been occasioned. Every degree of disorganization may, however, occur, even to the invasion of the larynx and trachea. An extreme loss of substance, if ultimate cicatrization should be accomplished, would entail stenosis of the windpipe requiring permanent wearing of the cannula.

Secondary Hemorrhage.—Bleeding may take place at any time during the after-history of a case until all ulcerative tendencies have been arrested. It may be due to the reopening of a vessel wounded during the operation, to the erosion of the coats of a vessel through the pressure of the cannula, or to the falling of a slough. Not infrequently the expectoration becomes tinged with blood from time to time. This is due in most instances to slight erosions of the tracheal mucous membrane by the cannula, most frequently at its point, and calls either for greater gentleness in the manipulations about the cannula, or for a change in the tube itself, so that, by having one of a different length or different curve, the ulcerating point may be relieved from pressure. Many cases of profuse and fatal secondary bleeding have been reported. Such hemorrhages are due usually to eroded tracheal vessels, but may be due to the opening by ulceration of some vessel in the external wound. In a number of reported instances the innominate artery has been the source of the bleeding. The possibility of serious secondary hemorrhage should always be borne in mind, and every care should be taken to prevent or limit the ulcerative processes upon which it depends. When a large vessel is the source of the bleeding, the immediate inundation of the air passages with blood will cause speedy death. If the bleeding is less overwhelming in its onset, the bleeding point must be sought for, and the flow stanched by the use of the ordinary means available for hæmostasis.

THE TRACHEA.—*Pseudomembranous Exudate.*—The extent and character of intratracheal exudations is one of the most important conditions upon which the success of tracheotomy depends, especially in cases in which the operation is performed in the course of diphtheria. The amount of the tracheal mucous surface that may become involved in the pseudomembranous exudate varies much, and it is generally impossible to determine, previously to the opening of the trachea, whether the exudate extends below the larynx or not; in a large proportion of cases it remains limited to the larynx throughout; in others, if life is prolonged by tracheotomy, it afterward extends to the trachea and to the bronchi; in many the trachea is involved from the first; of these, in some, after the exfoliation of the exudate already formed, no further deposit occurs; in others its progressive formation leads irresistibly to death. When the trachea already contains an exudate at the time of operation, more or less extensive particles of it, accompanied by much muco-pus, will often be ejected through the incision when made. In other cases, in which the exudate is still adherent, it may be possible to secure the detachment and expulsion of portions of it by the introduction through the wound into the trachea of suitable instruments, as already advised in a previous section.

The readiness with which exfoliation of the membranous exudate takes place, depends upon the degree to which its elements adhere to and penetrate the mucous membrane beneath, which again is a very fair index of the intensity of the local inflammation. The cases marked by a ready exfoliation are those in which the depth and intensity of the local disease are slight, and which give a ready hope for recovery, provided that the special dangers incident to the location of the deposit be overcome.

In many of the cases in which the loosened exudate is ejected upon the first opening into the trachea, or is easily removed at once, unimpeded and speedy recovery will ensue if only the simplest precautions be taken to protect from hurtful extraneous influences.

Much more frequently, however, the detachment of the membrane is delayed, and it takes place in smaller masses, of varying size, that appear from time to time in the expectoration during the after-progress of the case. These loosened pieces of membrane, usually mingled with viscid mucus or muco-pus, are often expelled with difficulty; they provoke suffocative crises that for a time seem to threaten the utmost peril; and in not a few instances, when skilled and instant assistance is not rendered, they produce death by blocking up the lumen of the trachea, or of the cannula that may be in use. In any case in which there has taken place a membranous exudate within the trachea below the point of incision, such a suffocative crisis is likely suddenly to arise at any time during the period of its exfoliation. These are the cases in which the ultimate result depends directly upon the completeness with which the indications presented by the presence of this loosening membrane are appreciated, and the faithfulness and thoroughness with which they are carried out.

Catarrhal Inflammation.—Some catarrhal inflammation of the tracheal mucous membrane always accompanies a membranous exudate, and frequently causes conditions that complicate greatly the after-treatment. It is liable to be excited *de novo*, in cases not associated with membranous exudate, by the inhalation of unmodified air—cold, dry, and dust-laden—through the new respiratory aperture. It may extend to the smaller bronchi; it is the immediate cause of death in a considerable proportion of cases after tracheotomy.

Even in cases in which the catarrhal inflammation does not extend beyond the trachea or the primary bronchi, the secretion may be so copious and so viscid that the air passage can be kept clear with difficulty; where there is membrane also present, it is by the catarrhal secretion that the membrane is lifted up and disintegrated; this secretion mingles with the membranous shreds that are expectorated and may cement them together in masses too large to be expelled without assistance; it clings to the interior of the cannula, where it readily dries in the air current and forms incrustations that rapidly diminish its lumen. The greatest trouble from this catarrhal secretion is usually experienced within the first three or four days after tracheotomy. It then either diminishes greatly in quantity, or becomes muco-purulent and diffluent. In many cases the character of the secretion has already become muco-purulent before the incision into the trachea is made, in which case its copious and ready expulsion through the opening then takes place.

The indications for treatment of catarrhal inflammation of the trachea are to limit its extent, to modify its intensity, and to obviate dangerous accumulation of its secretions.

The first two indications may be fulfilled by the same measures. Whatever remedial measures have been recognized as of value in the treatment of inflammations in general of the respiratory mucous membrane, will be of equal value in these cases, and will be applied according to the experience of the individual practitioner. Calomel, antimony, and muriate of ammonia each possess a positive influence in promoting free secretion and rendering it less viscid, but in the majority of cases dependence will be mostly placed on local applications.

The air inspired must be warm, moist, and pure. The use of the moist sponge or gauze veil over the mouth of the cannula, advised in a previous section, should be kept up. If necessary they may be held in place by tapes fastened at either side, and tied over the head or around the neck. In addition to this precaution, whenever difficulty is being experienced by the patient in fully coughing out the tracheal secretions, inhalations of vapor, instillations and injections of liquids may be practised. Inhalations of steam, of steam charged with vaporized Peruvian balsam, with atomized lime water, or with solution of muriate of ammonia, may be used with benefit. Instillations and injections are also of great advantage. When the symptoms are not urgent, three or four drops of warm water and chloride of sodium, of lime water, or of dilute lactic acid, may be made to run down through the tube into the trachea as often as seems to be necessary to keep the secretions diffluent and the expectoration free. Whenever this is not sufficient to prevent the continued marked accumulation of secretions, whether of tenacious and inspissated mucus or of muco-pus and membranous débris, injections of the solvent liquid, to the amount of a drachm or more, are to be made by means of a syringe introduced deeply into the cavity of the trachea. For this purpose a small syringe, as a hypodermic syringe, having a tube attached to it of suitable size and curve to pass through the cannula, terminating in a perforated bulb, as shown in the illustration (Fig. 4745), is desirable. In making the injections, the bulb is quickly passed down through the cannula, or through the wound after the cannula has been withdrawn, for an inch or more into the trachea, and the liquid is injected with some force. A violent expiratory paroxysm follows, the diluted and loosened mucus is dislodged and expelled; after a minute or two the injection may be repeated, and will be followed by still greater relief. These injections may be repeated from time to time, as often as the reaccumulation of viscid mucus in the air passage is evident.

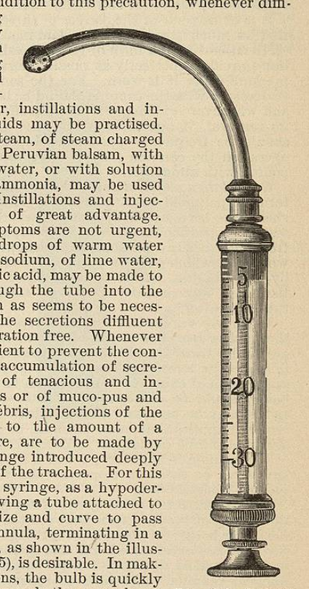

FIG. 4745.—Syringe for Intratracheal Injections.

Pressure Sores.—The possible erosion and ulceration of the tracheal walls from the pressure and friction of the cannula is always to be borne in mind. The mere pressure exerted by the cannula does not seem to be the only thing at fault in the development of ulcerations of the trachea, as the prolonged wearing of a cannula after tracheotomy for conditions other than diphtheritic croup, and even in many of these cases, without unpleasant pressure effects ever being experienced, is sufficient to prove. The vitality of a tissue which has been the seat of a diphtheritic exudation is diminished; it naturally tends to necrosis; the more intense the diphtheritic process, the greater the necrotic tendency. In such cases the slight additional irritation afforded by the pressure of the cannula suffices to determine a slough. That in the movements of the neck, and in the manipulations of the tube, frequent antero-posterior tilting of the cannula should be done is unavoidable; and it would be expected that the striking of the anterior edge of the inner end of the cannula against the anterior wall of the trachea in these frequent tiltings would cause that point to be the one at which ulceration should most frequently take place.

Many cases of mere erosion or of slight ulceration undoubtedly pass unnoticed. The most important symptoms which indicate the existence of ulceration are two —namely, the appearance of bloody streaks in the expectoration some days after the operation and a black discoloration of the lower end of the tube.

It is on account of the danger of these pressure effects that so much stress has been laid in a previous section on the use of such a form of tube as shall in its construction provide as perfectly as possible against friction and pressure while it is worn. For the same reason efforts to dispense with the cannula should be begun very early, and whenever evidences of pressure effects are detected, its removal, if but for a short time at any one trial, should be frequently practised. In cases of the high operation the cannula may possibly sometimes be dispensed with altogether.

Granulation Vegetations. — Exuberant granulations, forming polypoid excrescences projecting into the trachea, have been noted by many observers; they may be sessile or pedunculated, single or multiple; they most frequently occupy the superior or inferior angle of the wound, at which points a small space exists not occupied by the cannula, which is early filled by granulation tissue and is constantly subject to the irritation of the tube thereafter.

Whenever vegetations are discovered protruding into the trachea from the angles of the tracheal wound, they are to be treated as exuberant granulations would be in any other locality. They are to be destroyed by the application of caustics, or if they can be torn away their bases should be cauterized. Whatever operative procedure may be necessary to make them accessible to the required applications must be done, as their presence is always a source of danger. Whenever a prolonged use of the cannula is necessary, a watch should be kept for any signs of their development and their growth repressed from the first.

Chronic Hypertrophic Subglottic Laryngitis.—A chronic thickening of the soft parts between the vocal cords and the lower border of the cricoid cartilage is an occasional sequel to laryngeal diphtheria, and by the stenosis which it causes makes necessary the prolonged retention of a tracheal cannula. Attempts to relieve the obstruction by laryngotomy and excision of the obstructing tissues have been uniformly unsuccessful.

Care of the Cannula.—A constant watch over the cannula should be had from the moment of its introduction until either it is possible to remove it altogether, or the trachea has become accustomed to its presence and the tracheal secretions are normal. The surgeon must see that the nurse is thoroughly familiar with the mechanism of the double tube and knows how to remove and replace the inner tube with the least possible disturbance to the patient. It is especially desirable that the care of the cannula be entrusted to a judicious person who will not neglect it on the one hand, nor needlessly torment the patient on the other by useless fussiness over it. The inner tube should be removed only when there is a manifest occasion for it, as shown by some interference with the free passage of air. If the toilet of the trachea has been carefully made before the tube is introduced, the amount of expectoration will often not be very great during the first twenty-four hours; but if rapid breaking down of membrane, or a copious tracheal or bronchial catarrh coincides with the introduction of the cannula and occasions profuse expectoration, the tendency to clogging of the tube will be so frequently manifest that the removal of the inner tube and its cleaning will be required at comparatively short intervals. Even in cases which are not giving much trouble, obstructive crises are likely to develop suddenly at any time, caused by clumps of inspissated mucus, or pieces of exfoliated membrane, being driven into the tube by cough, or being brought up against its lower end so as to occlude more or less completely its opening. The extreme dyspnœa caused by such an accident, if not quickly relieved, will soon end in death. If the removal of the inner tube does not relieve the symptoms, the whole tube should be removed, and the needed measures to clear out the trachea be carried on through the unobstructed wound. When the inner tube is to be removed, the shield of the outer tube should be steadied by the thumb and forefinger of one hand, while the inner tube is disengaged and withdrawn with the other hand. The withdrawn tube should then be dropped into a cup of warm water, in which it should be left for a short time in order to soften the more or less inspissated mucus within it. Then a small mass of cotton-wool or a piece of sponge should be pushed through it, so as to clear it out. A splint from a broom will always be available for the purpose of pushing the cotton or sponge through, and is to be chosen rather than a wire or hairpin; for the latter, if not very carefully used, may scratch and mar the soft metal of which the tube is made. The tube having been cleaned out, it should then be rinsed in the water and replaced. The inner tube ought not to be left out any longer than is necessary to clean it, lest, when it is replaced, it push before it a possible mass of inspissated mucus, gathered on the inside of the outer tube while the inner one has been out, which by the time the tube is down in place may become a plug sufficient entirely to occlude it.

The outer tube may usually be left in place, without being disturbed, for the first two days. At the end of this time, that is, at the close of the second or the beginning of the third day, it will be desirable to remove the whole apparatus for the purpose of cleaning up. By this time the wound borders will have become somewhat firm, so that the opening down to the trachea will remain patent for a while without the tube, and sufficient time can be had to clean up the wound and the parts about, as well as to cleanse the tubes and arm them with fresh tapes. When the cannula is ready to be replaced, it will generally easily slip back into the trachea along the track which it has already made for itself, the walls of which are firm enough to guide the advancing end of the tube, if it is gently pushed along with proper regard to the direction which it should take. A hitch may occur when the end of the cannula reaches the entrance into the trachea, owing to the resilient cartilages having sprung back and partly closed the opening. If the tube has been kept out some time this obstacle is more likely to arise. Usually a little gentle pressure will overcome it, but care must be taken lest the tube be thrust down in front or at the side of the trachea instead of into it. The use of a conical-pointed pilot obturator (Fig. 4743) will always prevent any difficulty of this kind, and the surgeon would do well to be provided with one. The three-bladed dilator of Laborde is also very serviceable in overcoming such a difficulty. If the cannula track has not become quite well defined and firm, the hook retractors may be used to advantage for dilating anew the tracheal wound sufficiently to permit the cannula to pass.

If the walls of the wound are still so soft at this period that they fall together at once after removing the cannula, the wound must be kept open by a dilator while the necessary cares are given to it and a fresh tube is made ready for insertion. When this first change of the cannula is to be made the patient should be placed upon a table with the same arrangement as in the original operation, otherwise the surgeon may find himself at a very great disadvantage in his efforts to give the needed attention to his patient.

The further care of the cannula will differ according to the nature of the case for which tracheotomy has been done. If the tube is to be worn permanently, or until some cause of obstruction has been removed by subsequent operation, it will be left in place, with but rare changes. If the tube is one whose size and shape are adapted to the case, the trachea soon becomes accustomed to it so that it is borne without discomfort; the superficial wound heals rapidly, and the track of the cannula becomes a fistula with well-organized walls. If the operation has been done for the relief of temporary obstruction from inflammatory or diphtheritic disease of the

larynx, it will be desirable to dispense with the cannula as soon as the obstruction shall have cleared away sufficiently to permit air again to pass through the larynx. To determine this the tube should be removed at the end of thirty-six or forty-eight hours, with great gentleness, so as to alarm the patient as little as possible, and the wound opening should be occluded with two or three folds of moist muslin placed over it, so as to test the ability of the patient to respire through the larynx. Frequently, even as early as this, it will be found that the obstruction has cleared away and that the cannula can be permanently dispensed with. If, however, respiration through the natural channels be found still impossible, the cannula must be replaced. Each day the permeability of the larynx may be again tested for a time. If by the eighth day it shall appear that easy respiration through the larynx is not yet possible, it will rarely be due to the persistence of obstructive exudate or œdematous swelling, but will be caused in the most cases either by temporary paralysis of the glottic dilators, diphtheritic in origin, or by glottic spasm of emotional origin; less frequently it will be due to persistent submucous inflammatory swelling or to inflammatory infiltration of the laryngeal muscles. More rarely yet, the inability to do without the tube will be due to the tracheal conditions already described, viz., in-turned cartilages, collapse of the trachea, or polypoid granulation excrescences. Cicatricial contractions causing stenosis of the trachea, following upon extensive destruction of its walls by ulceration or gangrene, may also oblige the patient permanently to retain the cannula. Whatever the cause, it will be well now to suspend for a time the efforts to do without the tube. A week may be allowed to pass during which the larynx is left at rest, and efforts are made to improve the general condition of the patient by iron and strychnine, and the local paresis by faradization. At the end of this time the efforts to dispense with the cannula should be renewed. All the manipulations should be made with gentleness, accompanied by manner and voice tending to reassure the patient, who has learned to rely on the cannula for breath, and who regards its removal with apprehension. As soon as any marked distress is caused by the absence of the tube it should be replaced, and further attempts deferred until another day. If after three or four trials suffocative crises continue to follow quickly after every attempt to remove the tube, these efforts should be desisted from again for some time, a week or more. In the vast majority of cases a time will finally come when the tube may permanently be dispensed with.

Emotional laryngeal spasm is a condition which has frequently to be encountered in the effort to remove the cannula in nervous, excitable children. It may coexist with and thus aggravate the difficulties caused by other conditions, or may be the sole trouble.

This emotional condition is to be overcome by tact, patience, and time. Many artifices have been resorted to for conquering the nervous fear upon which the spasm depends. Gradual shortening of the cannula, even down to the point of a mere button resting upon the closed external wound, and gradual narrowing of the cannula until it is no longer a pervious tube, have each been resorted to successfully. The confidence of the patient in his ability to breathe without the tube must be awakened; how to do this must be left largely to the ingenuity of the attendants and the inspiration of the occasion.

Lewis S. Pilcher.

TRAGACANTH.—(*Tragacantha*, U. S., Br., P. G.; *Gomme adragante*, Cod. Med.) A gummy exudation from *Astragalus gummifer* L., and from other species of *Astragalus* (fam. *Leguminosæ*). The species yielding this gum are straggling, spiny shrubs of southwestern Asia, some of them extending into southeastern Europe. The gum is a product of the mucilaginous degeneration of the cell walls of the pith. At certain seasons it is subjected to a great pressure within the stem, by which it is forced out, in the manner indicated in the accompanying illustration, through any opening reaching to the surface. Many such openings occur from natural causes, while others are made for the purpose by the gum collectors. The form of the exudate varies somewhat with that of the opening, so that cylindraceous ("vermicelli"), ribbon-like ("flake"), tear forms, etc., occur. Most of the flake form is obtained from artificial incisions. The gum is gathered promiscuously by the collectors, and is carefully assorted by professional pickers after being

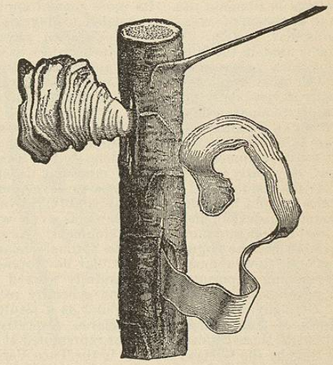

Fig. 4746.—Gum Escaping from Incisions in a Branch of a Tragacanth Shrub. (Baillon.)

marketed. There are numerous commercial grades, primarily designated by number, and depending upon the purity, solubility, and whiteness of the article.

Description.—In narrow or broad bands, more or less curved or contorted, marked by parallel lines or ridges, white or faintly yellowish, translucent, horn-like, tough, and rendered more easily pulverizable by a heat of 50° C. (122° F.).

On treating tragacanth with water, it swells and gradually forms a gelatinous mass, which is tinged blue by iodine T.S., and the fluid portion of which is precipitated on the addition of alcohol, but is not colored blue by iodine T.S.

Tragacanth consists of from one-third to one-half its weight of *bassorin* ($C_6H_{10}O_5$), an insoluble gum common to a number of commercial products (bassora gum, simaruba gum, cherry-tree gum, etc.) and of extended occurrence in the vegetable kingdom. It is capable of absorbing a good many times its weight of water, when it becomes transparent, soft, and jelly-like, but will not dissolve clearly when more water is added. Bassorin can be seen reasonably pure by putting a piece of tragacanth in a tumblerful of water and letting it remain, say, twenty-four hours until the soluble gum is dissolved out. About half of tragacanth consists also of a *soluble gum*, of the arabin series. Water, mineral substances, and impurities constitute the remainder. Tragacanth has no medicinal, and very little nutritive value. It is very largely used in the arts for sizing, mucilage, etc., and has considerable employment in pharmacy, where it is used as a basis of emulsions, for the suspension in liquid of powders and insoluble substances in "mixtures;" as a body for troches, etc. It appears in the following official preparations: *Trochisci Acidi Tannici*, *Trochisci Ipecacuanhæ*, *Trochisci Potassii Chloratis*, *Trochisci Santonici*, *Trochisci Zingiberis*, all of them belonging to the United States Pharmacopœia. There is a Mucilage of Tragacanth (*Mucilago Tragacanthæ*, U. S. P.) consisting of six parts of tragacanth, eighteen of glycerin, and enough water to make a hundred; this, diluted with about as much more water, will emulsionize cod-liver or