The Mathematics of Embalming Chemistry

Note:

This article appeared originally in the October '68 issue of the Dodge Magazine. Since we continue to receive requests for reprints of it, it seemed a topic worth a second look.

Few concepts can be more misleading and destructive to the professional future of the modern embalmer than the belief that "one-bottle embalming" is technically possible or even ethically admissible. The faulty reasoning behind this kind of wishful thinking is predicated on the premise that one single sixteen ounce bottle of embalming chemical can be made to contain *all* of the essential chemical components required for the complete embalming of the "average" case – regardless of the condition-variables present in such a case.

Certain unscrupulous "fluid merchants," who are actually not bona-fide embalming chemical manufacturers at all, have good reason to foster this misleading and unrealistic view. They do so with an obvious ulterior motive in mind. To put it plainly, they hope to win favor in the profession on the strength of a sensational economy appeal by claiming that embalming can be accomplished far more inexpensively with just one bottle of their super-duper elixir. Nothing could be further from the truth. To those who really understand the science of tissue preservation, such a claim smacks strongly of the chicanery and flim-flam of the old-time "medicine men" who in earlier days ranged the frontiers in their flashy horse-drawn vans and sold cure-alls "good for man or beast" to the trusting pioneer folk in the far-flung outposts of expanding America. Times have changed . . . but credulity, it seems, remains a dominant factor of human nature even in this enlightened day and age. Although stemming more from trustfulness than ignorance, unquestioning belief in the impossible and impractical still threatens the success of the misguided individual—but even more important, tends to undermine the very foundation of funeral service itself.

Misleading, illogical and technically faulty, the "one-bottle" concept must be explored in depth before its pitfalls can be made clear to all ethical embalming practitioners . . . for if allowed to gain momentum unopposed, such a trend can only give the critics and detractors of funeral service valid evidence to win public support for their destructive efforts.

In order to gain a true and realistic evaluation of the hazards inherent in the "one-bottle" concept, one might divide discussion of the subject into two parts. First, consider a hypothetically "perfect case" – one in which no type of chemotherapy had been administered prior to death and where no problems other than those met with in the normal course of tissue preservation face the embalmer. We must realize, of course, that no such case actually exists. But it gives us the unbiased starting point needed to expose the fallacies of the "one-bottle" embalming chemical concept and so reveal its hidden threat to the profession.

In cases where modern chemotherapy has been brought into play prior to death – and this encompasses some 90% of the cases treated by embalmers nowadays – the calculations for the analysis and critical evaluation must be revised. For here the hazards of "one-bottle embalming" take a sharp upward turn – and its inadequacy becomes greatly intensified.

We know, for instance, that cases in which the antibiotic *kanamycin* has been used for some time prior to death, require a much greater concentration of the arterial chemical than that indicated for cases which have not been treated with this drug. Expressed in its simplest terms, this requirement stems from the fact that the antibiotic causes changes in the kidneys. In consequence, the kidney tissues accumulate large concentrations of nitrogenous and ammoniacal wastes. And, as every embalmer knows, there is no more effective way to neutralize formaldehyde than reacting it with ammonia.

For the present, let's confine ourselves to an analysis of the "Perfect Case" . . . keeping in mind that it is purely hypothetical – for nowhere in our present chemotherapeutic era will the professional embalmer ever encounter such a case! Remember also that in any discussion concerning a topic such as this one, it is necessary to establish and ac-

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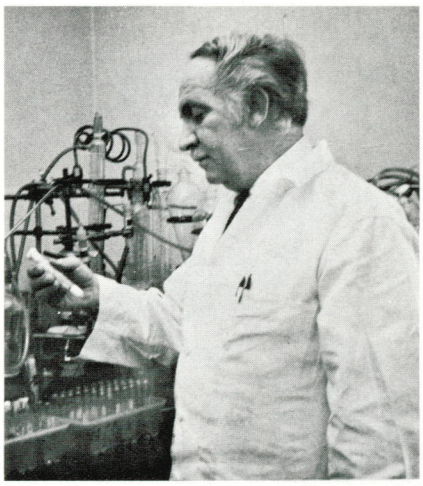

Dr. Fredrick

cept certain basic scientific assumptions. While these may not apply directly to 100% of our cases in actual practice – "perfect" or otherwise – they do take into consideration the most common variables and so hypothesize a truly realistic and typical "specimen" case. For example, an *average* adult cadaver weighing *65.3 kilograms* (or 65,300 grams) has been shown to contain a *total protein* content of 10.7 kilograms (or 10,700 grams of protein), by Brozek et al. (Ref: *N.Y. Academy of Sciences, Annals 110*:123. 1963.)

When formaldehyde reacts with protein, and *only* protein; – and here again, we simplify the discussion by deliberately overlooking the fact that formaldehyde will also react with *other* components of the human body besides protein, it requires about 4.0 to 4.8 grams (or *4.4 grams* average) of formaldehyde to react totally with and fix exactly *100 grams of a soluble protein.* Non-soluble proteins require even more preservative.

Now, as pointed out by Walker in his treatise (Ref: Walker, J.F. "Formaldehyde," 2d edition, 1953, Rheinhold Publishers, N.Y.C. p. 315), the 4.4 grams of formaldehyde are required to totally fix and preserve for "all times" the 100 grams of soluble protein.

The average cadaver has about 10,700 grams of protein. To totally and "forever" preserve *all* the protein present in this average cadaver, we would need:

10,770/100 X 4.4 = *470.8 grams of formaldehyde.*

Let us consider then, an average 16 ounce bottle of arterial fluid. If it contains only 30% formaldehyde (most modern arterials contain other preservatives in addition to formaldehyde) it would be technically defined as a "firming" or "high index" fluid. Its formaldehyde content is computed as follows:

1 U.S. fluid ounce = 29.6 ml.

16 fl. oz. = 473.6 ml. of fluid of which 30% is formaldehyde, and hence:

0.30 X 473.6 = *142.08 grams of formaldehyde.*

If we require 470.8 grams of formaldehyde to totally preserve all the protein in an average body, then that amount of this chemical in a 30% fluid will contain only enough formaldehyde to preserve:

142.08/470.8 = 0.3

or *30 percent of all the protein in that average cadaver.*

These calculations, as we pointed out earlier in this article, are necessarily predicated upon assumptions which must be accepted in order to establish a basis for computation. But even allowing the most liberal margin of error, it can be readily seen that *no single 16 ounce bottle of fluid* could possibly deliver the minimal acceptable degree of preservation – even in a "high index" formulation! And this, remember, is calculated on the conditions of an *average* case!

Yet, as theoretical figures, these must not be construed as applicable to *every* like instance. There are many truly capable and excellent embalmers whose professional standards demand the most critical technical perfection who can point to instances where they have achieved adequate preservation with as little as 1½ or 2 bottles of arterial fluid.

But none among them would rightfully claim that he uses only *one* bottle of arterial per case as *standard operating procedure* – for to do so would reflect unfavorably upon his professional judgment. Even the most ingenious and careful practitioners must admit that they are compelled to *vary* the concentrations of arterial chemical to meet the exigencies and special conditions present in each specific case. Most conscientious embalmers, in fact, use the full complement of adjunct chemical when the need for them is indicated – restorative humectants when there's evidence of emaciation or dehydration . . . water conditioners to neutralize chemical conflict in their solutions

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. . . modifiers, pre-injections, co-injections and vascular conditioning expedients. It is their familiarity with these tools of the trade which sets them apart as an elite professional class . . . where attitude and course of action is closely patterned on that of the medical man who employs every pharmaceutical and surgical expedient available to him as the need becomes apparent – and modifies his treatment according to the conditional factors present in the case at hand. Imagine, if you can, a doctor who would be content to use the *same drug* in the *same concentration* for every case he treats! The analogy is very close to "one-bottle embalming."

But even if it were possible to produce a reasonably acceptable, if not perfect, embalming result with the "one-bottle" tactic, the embalmer who chose to place such paltry economy above the true objectives of his profession would indeed be asking for trouble. For the value of his reputation can scarcely be counted in fluid ounces of arterial chemical. Sensibly enough, few are ready to risk so much for so little in return—and the profession can well spare those who fall by the wayside with "one-bottle embalming."

Now . . . back to the hard facts of embalming chemistry:

Even if it were technically possible to increase the amount of formaldehyde in a 16 ounce bottle of arterial chemical to an absolute 100% – we'd have barely enough to "fix" the total protein present in the "average perfect case." This, of course, is not feasible because of the intrinsic chemical-physical nature of formaldehyde. But mere "fixation" or stabilization of the body proteins does not constitute total embalming. The result of using such an arterial would be a rock-hard, ghastly grey cadaver – a far cry indeed from the lofty standards of modern embalming! And where would we put our diffusion-stimulating constituents in a 100% formaldehyde fluid? Our cosmetic modifiers, blood solvents and vascular conditioning components? Without these, could this super-duper 100% formaldehyde arterial do the job we want it to do? Could it penetrate and preserve *all* the proteins in our hypothetical "average" case? Could it get past the "average" number of circulatory obstacles we'd be almost certain to encounter in such a case? Lacking its normal complement of supporting constituents, it's hardly likely that this 100% formaldehyde fluid would win any applause from experienced professionals.

DEATH OF A CHILD

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They can help the couple see that each mourns in his or her own way, and that they can comfort each other by drawing closer together in loss.

For single parents, support can be found from friends and relatives. All parents should be encouraged to ask someone close to listen to their feelings.

Grandparents sometimes can be encouraged to help with other children or with practical chores. Being useful helps them cope with their double pain – at the loss of the grandchild and at seeing their own children suffer so.

CREMATION

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little room with two easy chairs, a table, and a draped wall. When the draperies were opened, I was astonished to see a cremation retort. Families are given the often exercised option of sitting in the room while the cremation takes place. Some people even help place the casket in the retort in a final humble act of reverence and devotion. Not for some, of course, but so right for others. Options, once again. That funeral director communicates his understanding for those who want cremation. He has enhanced it and made it beautiful.

Communicating about cremation is up to you. Don't jump to conclusions about what is wanted. Educate your community about the ways in which cremation can be incorporated in funeralization. Be aware that there are all sorts of reasons why families make this choice. Show a respect for families by allowing them as wide a choice of urns as you do caskets. Enhance the value of cremation by the way you offer it. Families feel loyal to you if you make them comfortable with their decisions. That is how you can improve communication about cremation, and it hasn't happened yet.