A teacher’s plea for a holistic model of hemostasis

Pedagogiskt docenturarbete

Niklas Boknäs
A TEACHERS’ PLEA FOR A HOLISTIC MODEL OF HEMOSTASIS

NIKLAS BOKNÄS

In my work as a hematologist, a researcher, and a teacher, I spend a lot of time trying to help other people make sense of hemostasis. During these interactions, I am often struck by how difficult people think it is to "get a grip" on this particular area of medicine. Regardless of whether I am advising my fellow clinicians on how to manage patients with bleeding and/or thrombosis or discussing the mechanistic basis of disorders with my students, I frequently find that people become uncharacteristically anxious and indecisive when faced with hemostatic problems that fall ever so slightly outside the scope of evidence-based medicine. When challenged to reason their way towards an actionable conclusion, their otherwise implacable decision-making skills become compromised by an irrational deference to isolated pieces of information, without proper evaluation of the larger context. This failure “to see the forest because of all the trees”, as the Swedish saying goes, impedes their ability to make adequate clinical assessments.

So what is this problem really about? In my experience, it is usually not caused by an ignorance of facts. Rather, the problem seems to stem from an incapacity to develop the "pattern recognition" skills that are required for efficient clinical decision-making. According to a typology developed by Taber (Taber 2001), this kind of learning impediment stems from a failure to integrate new and pre-existing knowledge into a coherent cognitive structure, resulting in a persistent state of knowledge fragmentation. This fragmentation prevents the development of "holistic recognition", a hallmark feature of the transition from "novice" to "competent" skill level according to Dreyfus’ model of skill acquisition (Dreyfus 2004; Peña 2010).

Admittedly, the hemostatic system certainly presents some rather unique pedagogic challenges. For one, it suffers from a kind of physical "structurelessness" that makes it less intuitively
relatable for the learner than many other areas of medicine. Traditionally, scientific knowledge of the biological systems that are critical for human health has been subdivided into disciplines arranged in a didactic hierarchy, with anatomy, histology and embryology at the bottom, and disciplines such as physiology and pathology at the top. Far from being arbitrary, this typology says something fundamental about how our minds operate when trying to make sense of medical knowledge. To students and researchers alike, it conveys the important message that, when trying to make sense of a biological system, it is useful to start by studying its overall structure, mapping out the interrelationships between its various components. This initial “structuring” activity (i.e. the study of anatomy and histology) lays an important ground-work for subsequent didactic endeavors to address more complex questions about causality (the focus of higher-level disciplines such as physiology and pathology). It also establishes a cognitive connection between the new subject of study and the physical world which we all experience.

From this perspective, an initial focus on getting the student acquainted with the physical structure of a biological system (e.g. an organ) can facilitate subsequent learning activities by: (a) providing the student with a relatable conceptual framework that can be used to create “meaning” (Ausubel 1961); and (b) creating a connection between the new material and the pre-existing cognitive structure of the learner. However, in order to solve the very different problems posed by a leaking retinal capillary and a ruptured femoral artery, the hemostatic system has, much like its close phylogenetic relative the immune system, evolved as an inherently decentralized system with an unparalleled ability for exponential amplification of system activity in time and space. As a consequence, a thrombus – the physical manifestation of hemostatic activity – can form at any position in the body and grow into almost any size. Further, as hemostasis is a “first responder” system, bridging the time between vascular injury and tissue regeneration, thrombi are transient structures that spontaneously dissociate within hours or days. Taken together, these system properties pose unique problems for researchers, students and clinicians when trying to erect a conceptual framework that brings meaning and structure to our knowledge about hemostasis. The methods traditionally on offer by disciplines such as anatomy and histology are of scant use, since they have been designed for the study of systems that are stable over time and have defined positions and scales. In lieu of such a physical dimension to our knowledge, we are forced to turn to other, less concrete conceptual models to structure our knowledge-building activities around.

Unfortunately, most of the conceptual models of hemostasis that are presented to students during their educational training leave them in a state of conceptual myopia. By zooming in on a specific subset of the processes involved, they tend to exacerbate rather than relieve the fragmentation of knowledge that gives rise to the cognitive incoherence discussed above. For example, although the incredibly influential waterfall/cascade model (Davie and Ratnoff 1964; Macfarlane 1964) certainly provided a very eloquent protein-centric model that connected the dots on blood coagulation in the 1960s, its complete omittance of the crucial contribution of platelets and vascular cells to hemostatic function put severe limits on its value as an introductory model that can help students become familiar with the topic. Despite these obvious limitations, the waterfall/cascade model continues to have an outsized influence on how we conceptualize hemostasis to this day, as demonstrated by its dominant presence in both of the most popular textbooks in physiology among medical students (Hall and Hall 2021; Boron and Boulpaep 2017).

Didactic models are conceptual frameworks that “facilitate understanding and improve practice by selecting the most relevant elements and discovering the interdependent relationship between them” (Rodriguez Sandoval, Bernal Oviedo, and Rodriguez-Torres 2022). They can be viewed as roadmaps that provide guidance on how to tailor the content and form of learning activities to achieve a set of learning objectives in a specific educational context (Thalheim 2010). In this context, it is perhaps relevant to emphasize that a purposefully designed didactic model should
take the entire didactic process into account, starting with the transformation of scholarly knowledge into teachable knowledge. This critical first step (sometimes called the external didactic transposition (Chevallard and Bosch 2014)), is a complex societal process in which scientific content is “mangled” through the academic community until it finally finds its way into the textbooks and curricula that shape the educational content of our academic institutions. In part, this is a political process, shaped by the power-balance between the various stakeholders that influence the discourse in an academic discipline.

When envisioning a didactic model that could address the problems I have identified in this text, it becomes clear that a multi-pronged strategy is needed. Certainly, increased usage of student-centric pedagogic approaches, such as problem-based learning (Trullàs et al. 2022; Yew and Goh 2016), would cover some of the distance by stimulating the development of problem-solving skills among students. However, in this context, interventions that aim to change how we teach can only take us so far without a substantive change in what we teach. In my opinion, what is needed is the kind of synthesis of these two dimensions of learning that was envisioned by the educational psychologist Lee S. Schulman when elaborating on his concept of pedagogical content knowledge: “the most powerful analogies, illustrations, examples, explanations, and demonstrations – in a word, the ways of representing and formulating the subject ... that make it comprehensible to others” (p. 9) (Shulman 1986).

As my thinking about the art of teaching hemostasis has evolved over the years, I have become increasingly convinced that pedagogical content knowledge is precisely what is missing as we – the educators in the field – are failing to meet the needs of our students. We exhibit a curious inability to rewire the process of external didactic transposition and gear it towards integration instead of further fragmentation. The incoherent structure of what we teach translates into a cognitive incoherence in our students, which in turn has negative ripple effects on their acquisition of clinical decision-making skills. To reverse this unfortunate logic of fragmentation, we must become iconoclasts, ridding ourselves of the fragmented and outdated conceptual schemata we have gotten used to and replace them with coherent didactic models that enable a holistic understanding of hemostasis. These models should be evaluated empirically by measuring their ability to support the development of practical problem-solving skills in clinical contexts. So far, I find that the most promising candidate on offer is the so-called “cell-based model of hemostasis” presented by Hoffman & Monroe in 2001 (Hoffman and Monroe 2001; Monroe, Hoffman, and Roberts 2002). From a didactic perspective, a uniquely attractive feature of this model is that it connects all of the major components of hemostasis, enabling us to view them as interdependent nodes in a functional network. I believe that a thorough integration of the cell-based model of hemostasis into our educational practice could go a long way in providing the conceptual synthesis that is so desperately needed in the field. It is unfortunate that this laudable work has found it so hard to find its way into the textbooks, classrooms, and minds of our students.

REFERENCES


