

## The “Make Surgical Pathology Easy” project: learning Pathology through tailored digital infographics - the case for renovation of an old teaching method

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### Summary

The term ‘infographics’ is a blend of the two words “information” and “graphics”. Infographics can be described as ‘information visualizations’, conceived as visual translation of data including text, numbers, graphs, charts, drawings and so on. Visual representations are a fundamental part of scientific communication. They match the need to organize different pieces of information in a coherent and synthetic structure and constitute one of the most effective methods scientists rely on to divulge their findings. In particular, infographics provide an overview of key points regarding specific topics in a form that promotes quick learning and knowledge retention. They can be presented in printed or digital formats, being the latter particularly suitable for a global-scale diffusion via social media or websites.

In recent years, many pathologists have started developing digital infographics as a strategy for providing free educational contents on Facebook, Twitter or websites. In the present review, we focus on the value of digital infographics to summarize various aspects of Surgical and General Pathology. They shed light on diagnostic criteria, differentials and predictive/prognostic markers for many diseases, being a useful learning tool both for residents and practicing pathologists. In this paper, the model of infographics ideation, processing and sharing to an online audience is described and the impact of infographics on knowledge processes in Pathology is investigated.

**Key words:** pathology education, drawings, digital infographics, social media

### The role of Surgical Pathology: where different visions merge

Pathology is the medical specialty which concerns the examination of tissue specimens for diagnostic purposes. Actually, it is an interdisciplinary field where a plethora of different information, from clinical to molecular, converge and are gathered to reach a diagnosis. In order to begin its speculations, Pathology must fulfil the task of bringing into view its specific object of study, which is not directly accessible to senses: the microscopic world of injured tissues. From gross inspection of surgical specimens to microscopic examination of tissue slides, the diagnostic process is led through the observation and interpretation of images, making Pathology a constitutionally visual discipline.

While the observational process is carried on, several background information act as a filter. Namely, the pathologist’s interpretation process is always directed and influenced by additional data – such as medical his-

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tory of the patient, clinical presentations, imaging features of the lesion and other details which are not an intrinsic part of the Pathology domain. These notions represent the specific context in which the pathologic diagnosis is set. Consequently, diagnosing images in Pathology is based on a complex interplay between perception, cognition and ability to integrate informations.

In Pathology, at baseline, education is imparted in both visual and experiential forms <sup>1</sup>. During their residency programs, pathologists are trained to scan/search through histological slides, rapidly process visual stimuli and extract key elements from the scene they are looking at.

With time and experience, this sequence becomes automated but the development of a visual expertise and procedural knowledge in Pathology is an intricate process that requires an innate observational aptitude, appropriate training and adequate feedbacks. By referring to the different learning styles in Pathology, “learn by doing” (converging style) prevails among residents; as pathologists mature, “learn by observing” with the application of prior experience to problem-solving (diverging style) and conceptual thinking (assimilating style) become dominant <sup>1</sup>.

## Cognitive strategies in Pathology and pattern recognition

Pathologists use cognitive processes, such as perception, attention, memory and search, to collect data from the case, including macroscopic and microscopic findings and clinical or radiologic information. Based on these data, hypotheses are elaborated, and then checked against the data <sup>2</sup>.

Histopathological images can be considered as multi-layered texts with their own internal narrative. The pathologist’s eye must be tuned to detect at a glance the essential features in a histological image. Such features are defined as ‘diagnostic criteria’ and describe salient characteristics of cells, cellular arrangement in specific structures and the relationship of cellular structures with the surrounding tissue environment. A specific set of criteria constitutes the ‘pattern’ of a given disease, a kind of ideal representation of that disease which each pathologist bears in mind as a template. Pattern recognition at microscopic level is a multistep process including visual examination of the slides, the assessment of morphologic criteria and the association of a specific combination of criteria with a pathologic entity.

As Pathologists become more familiar with how normal and abnormal, benign and malignant, and how

one disease versus another look like (as well as possible variations), they become more efficient at extracting relevant image features required to render accurate diagnoses <sup>3</sup>. Therefore, in pathologists with well-structured competences and a robust visual expertise, the process of pattern recognition happens in a fluid, spontaneous and almost immediate manner, through a well-run feature extraction analysis. However, reaching such a level of integrated consciousness requires struggle and intense learning effort <sup>4</sup>.

Pathologists have to process a large quantity of theoretical information, they need to learn about different types of subjects and, most importantly, their knowledge needs to be retained.

However, in many domains and sub-domains of Pathology, the list of common and rare diagnostic entities may be rather large so that becoming acquainted with each of them is virtually impossible, resulting in a partial learning.

Furthermore, medical education, including education in morphological sciences, is mainly imparted by promoting an analytical learning style, a deliberate rule-based method of solving a problem or reaching at a diagnosis <sup>5</sup>. Sequential learning is excellent for conceptual topics but inefficient for topics, involving pattern recognition <sup>5</sup>, which require integration of different levels of information and a strong anatomo-clinical correlation.

## Tools to build a visual expertise: visual methods

Gaining confidence with pattern recognition occurs as a function of time spent on learning and the number of images viewed during a certain period of time <sup>6</sup>. However, other factors deeply influence the efficacy of learning through images. In fact, a gap exists between the ideal representation of a certain disease, its estimated pattern and images pathologists are faced with in their routine practice. Typically, not all diagnostic criteria are simultaneously present in individual cases of a certain disease. Some diagnostic clues may simply be lacking due to the intrinsic biological diversity of single specimens, others may be unrecognizable due to supervening artifacts. In addition, the timing of the disease at the moment the biopsy is taken and other factors can dramatically modify the way the disease looks in a certain specimen, from case to case.

In this context, the use of visual methods is of invaluable help in facilitating the process of learning and fill the gap between blurred chaotic reality and coherent scientific models <sup>7</sup>.

Visual methods can be broadly defined as all kinds of

visual materials which can be employed in education and research to build and disseminate knowledge. They are extremely heterogeneous and include drawings, photography, videos and artworks of various types. Drawing, alongside with photography, has traditionally been the most commonly used visual method in Pathology education.

### The role of visual methods in Pathology from a historical perspective

Producing visual representations is constitutive to sciences and a fundamental part of scientific communication and knowledge production. Illustrations are a powerful tool to circumvent the limits of human comprehension when it is challenged with the theoretical and the invisible.

They match the need to give shape to what cannot be routinely experienced and constitute perhaps the most effective method scientists rely on to divulge their findings. Illustrations can condense and express in a more accessible form concepts that result from complex elaboration of data. The birth of visually-oriented medical disciplines was strongly linked to the production of illustrations. Historically, before the invention and diffusion of photographic techniques, manual drawings were the only visual tools to document the observations made under experimental conditions, at macroscopic and microscopic level<sup>8</sup>.

Drawing firstly emerged as a powerful form of recording new findings and describing the disease processes, superior to any verbal description. For this reason, the great anatomists and pathologists of the past closely collaborated with artists to include detailed illustrations in their treatises. For example, Andreas Vesalius' revolutionary work *De Humani Corporis Fabrica libri septem*, which is considered a cornerstone in modern Anatomy, was enriched with more than 150 exquisite woodcut illustrations. Often, however, anatomists and pathologists were artists themselves, like the father of neurosciences and laureate Nobel Santiago Ramón y Cajal. He is best remembered for shedding light on the structure and function of nervous system and the development of his 'neuron doctrine'<sup>9</sup>. Using special staining techniques to selectively visualize the neurons, he reconstructed in single sketches the results of multiple microscopic observations made in different focal planes. With this procedure, he could render a visual representation of the neural networks as they could not be directly visualized, but only deduced from a series of independent observations<sup>10</sup>. Among the contemporaries of Ramón y Cajal, Camillo Golgi was

the first to describe and draw the "internal reticular apparatus", while Enrico Sertoli summarized his observations on testes' morphology in the drawing of a pattern, becoming the forerunner of all subsequent schematic representation of testis in the histology manuals<sup>11,12</sup>.

The most prolific of medical illustrators was certainly Frank Netter, who created more than 4000 pictures for CIBA pharmaceutical company alone<sup>13</sup>. The extraordinary ability to capture the essential lines of a given anatomical region or physiological/pathological process is central in Netter's artistic sketches.<sup>14</sup> He created dramatic images, which are superb medical illustrations and powerful teaching aids, and still widely used by both students and experienced practitioners<sup>13,14</sup>.

A modern example of illustration in Pathology is Donald Gleason's graphic presentation of prostate cancer progression patterns. Dr. Gleason managed to illustrate in a single image the entire biological spectrum, presented as a continuum, of prostatic acinar adenocarcinoma. A simple hand-drawing could recapitulate the results of years of research and hundreds of observations in a neat, swift and yet very informative manner, still unsurpassed after more than 60 years<sup>15</sup>. These emblematic cases highlight how illustrations are not just a means to passively reproduce forms as we perceive them but, most importantly, they are instruments that go beyond and reveal what is concealed in perceptions.

Producing visual representation is an experimental act and integral part of the investigative process so that images can be considered substantial cognitive instruments. Nowadays, despite the ubiquitous and large-scale availability of microscopic photography, which can better accomplish faithful reproductions of an object of interest, drawing and illustration still play an irreplaceable role in Pathology research and education<sup>16</sup>, giving emphasis to details which may not be evident in a photograph.

Obviously, with the passing of time, graphic techniques have evolved. Manual drawing has been partially replaced by digital drawing. On the other side, drawing has gradually lost the urge of being representational and strengthened its function of integrating notions and presenting them in a comprehensive and synthetic form. This tendency mirrors the need to simplify and control the extreme and constantly growing complexity of modern medical knowledge. Simple illustrations have given way to more sophisticated forms of visual representations called infographics, including graphs and texts and incorporating a high number of information from different interconnected domains.

### Infographics: an overview

The term ‘infographics’ is a blend of the two words ‘information’ and ‘graphics’, so can be described as ‘information visualizations’. In that sense, they can be seen as a ‘knowledge assemblage’ including text, numbers, graphs, charts, drawings and so on <sup>16</sup>. Infographics are an innovative and engaging method of visually communicating information in a colorful and concise manner <sup>17</sup>, translating complex data, be it research or medical, into smaller, more relatable amounts for the individual to understand <sup>18</sup>.

Information are more likely to be retained if learnt from an infographic than from text or verbal communication alone <sup>19</sup>. Infographics create a new platform where visual materials can be gleaned in a faster way and better fixed in memory, being particularly suitable for medical education <sup>20</sup>.

A summary of the many roles of infographics in medical education is provided in Figure 1.

In the field of Pathology, infographics are increasingly

shared by free open-access websites and social media platforms such as Twitter and Facebook. Our goal is to describe the conceptual model of ideation, processing and translation to a big audience of the Infographics collected in the educational project called ‘Make Surgical Pathology Easy’.

The project was started in 2018 by Dr. Abhijit Das, albeit the ideation and conceptualization of the designs had been initiated long back during his post-graduation period at ‘All India Institute of Medical Science’ (AIIMS) in New Delhi, India. Over the course of 3 years (from January 2018 to May 2021) a total of 123 infographics were developed and shared for free on Facebook and Twitter.

The infographics published by Dr. Abhijit Das are hand-drawn schematic images (artistic pencil-sketches) placed on PowerPoint slides and then labelled accordingly. They cover various aspects of Surgical and General Pathology and follow a holistic approach in the understanding of the diagnostic process, providing different levels of information. These include the classifi-

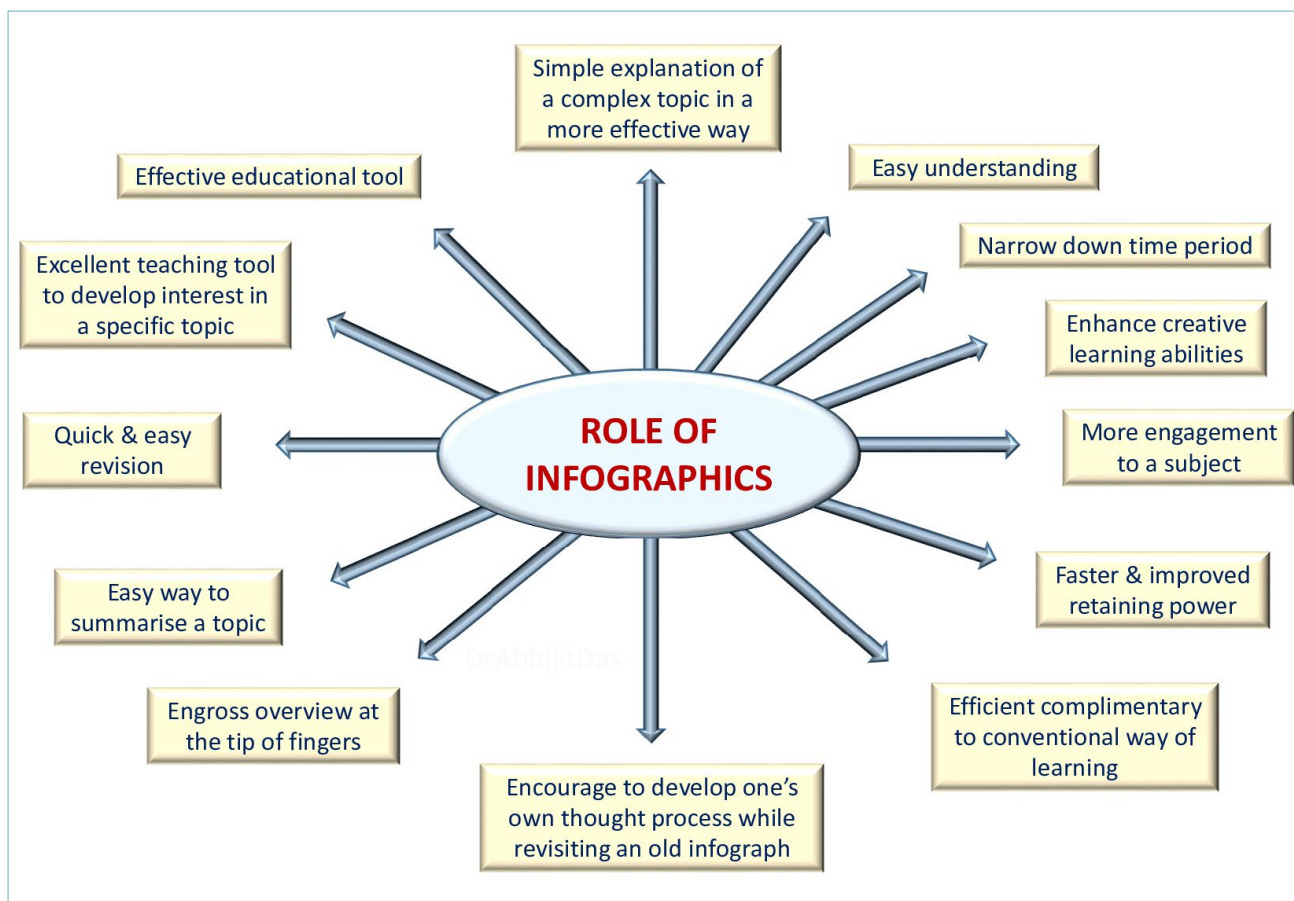


Figure 1. Role of infographics in medical education.

cation and pathophysiology of neoplastic and non-neoplastic diseases, the definition of the histopathological and immunohistochemical features and the explanation of common molecular pathways. Thus constructed, infographics shed light on diagnostic criteria, differentials and predictive/prognostic markers for a particular disease or a particular group of diseases.

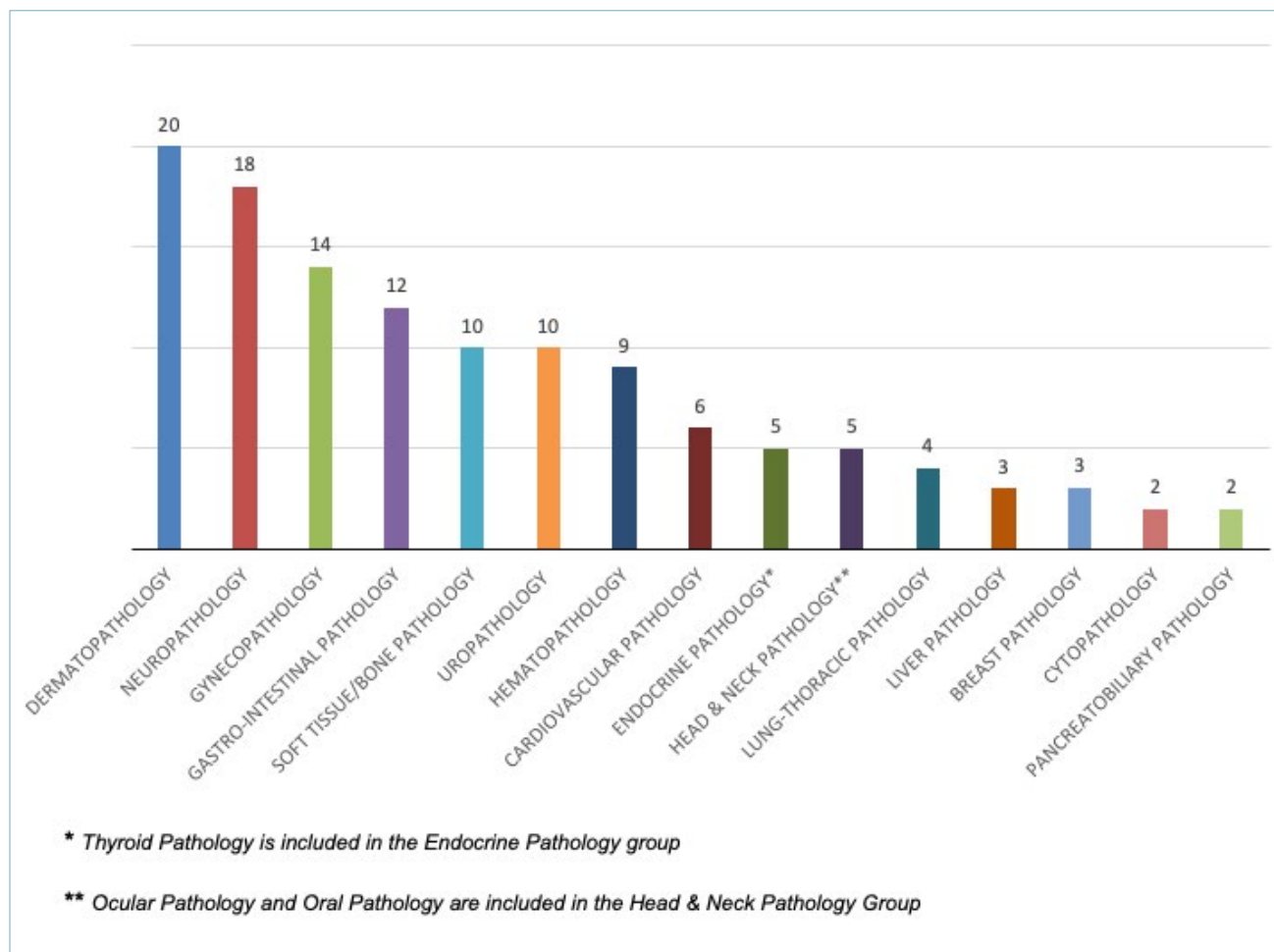
The number of infographics for different subspecialties topics is shown in Figure 2.

Infographic design is a simple step-wise process starting with the selection of a particular topic of discussion (e.g. posterior circulating stroke, Fig. 3). A comprehensive and thorough understanding of the concerned topic is of utmost importance and can be obtained from any valid source. Recent updates and developments related to the topic should be included and supplemented by formulating notes (e.g. percentage of ischemic stroke, etiology, normal anatomical variant of blood supply, most common sites for verte-

bral dissection etc., Fig. 3). In the next step, all robust information is selected, critically reviewed and sorted to build a coherent storytelling. At this point, considering proper utilization of space, a tentative sketch of the storytelling is created on a plan paper using colored pencils and markers. The final sketch is then placed on a PowerPoint slide for labelling. This process is often carried out by a professional team of graphic artists for proper alignment and organization of text in relation to the schemes. The PowerPoint slide is then saved as image (.tiff or .jpeg format, Fig. 3)

It can be difficult to find all salient morphological features of a particular disease in histopathology slides. In this respect, an infographic can be of great value by summing them up in a single image.

For example, a single histopathology slide might not contain all typical morphological features of classic chordoma (i.e. vacuolated cell nest, cords, myxoid background and physaliphorous cells etc.), which



**Figure 2.** Number of infographics for different Pathology subspecialties.

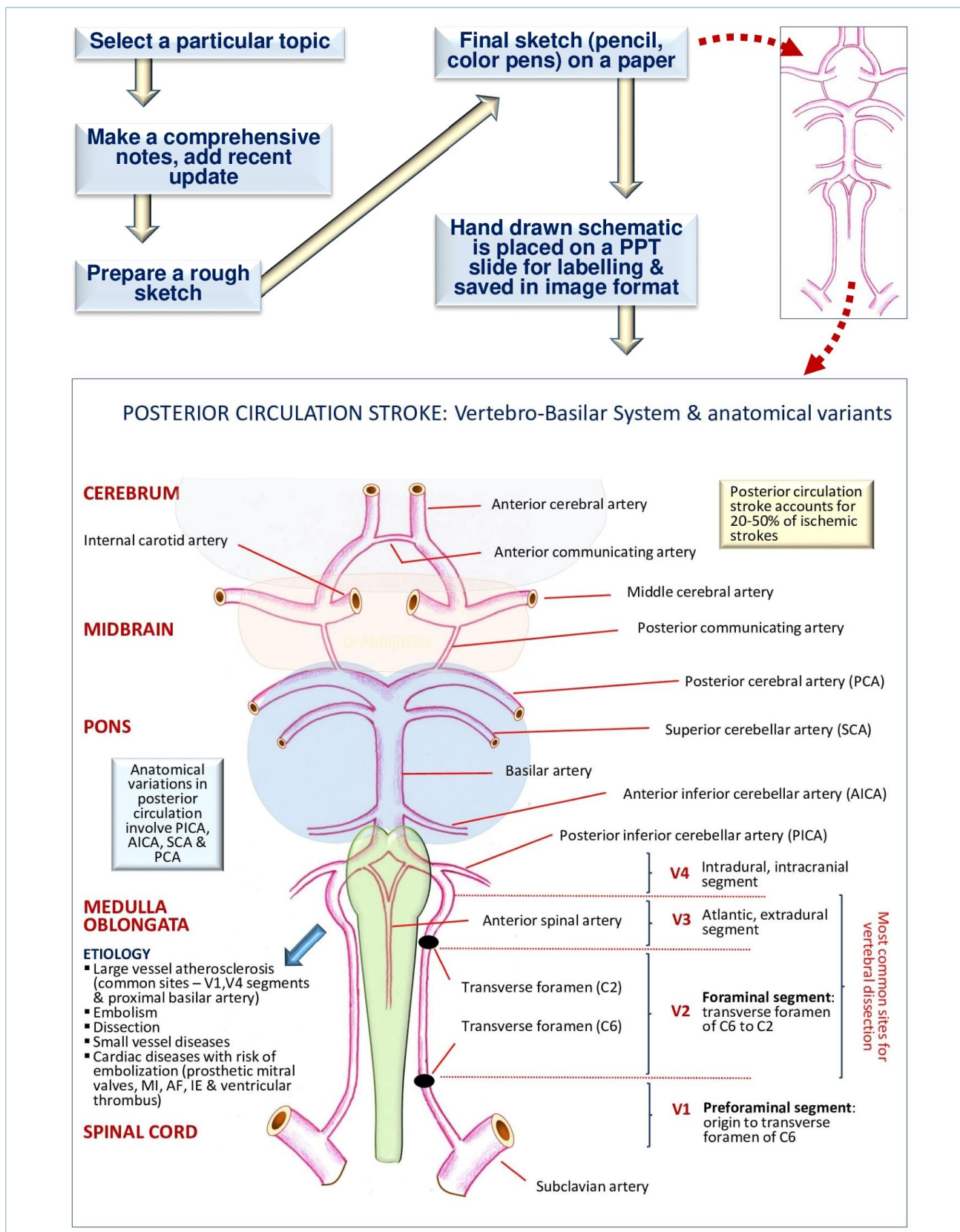


Figure 3. How to make an infographic, posterior circulation stroke.

can be instead presented simultaneously in one infographic (Fig. 4). Moreover, the same infographic can contain the morphological features of the other types of chordoma (e.g. chondroid background in chondroid chordoma, spindle cell component and the numerous mitoses in dedifferentiated chordoma, Fig. 4). Lastly, supplemented information (e.g., basic immunohistochemistry panel for chordoma, Fig. 4) can be added to make the whole infographic a complete resume of current diagnostic knowledge about a topic.

Infographics related to a particular group of diseases are intended to provide maximum information in an exhaustive and simplified manner. For example, a single infographic representing ‘pemphigus and its differentials’ (Fig. 5) can easily illustrate the notable features of subcorneal vesiculobullous diseases (i.e. pemphigus foliaceus, bullous impetigo, subcorneal pustular dermatosis & staphylococcal scalded skin syndrome), as well as bullous diseases with suprabasal cleft formation (i.e. pemphigus vulgaris, Darier disease, Hailey Hailey disease, Grover disease & paraneoplastic pemphigus etc.) This type of infographic will certainly help to summarize one particular topic in an effective and faster way.

The ‘Make Surgical Pathology Easy’ infographics can be accessed directly from Facebook page ([https://](https://www.facebook.com/AbhijitSurgPath)

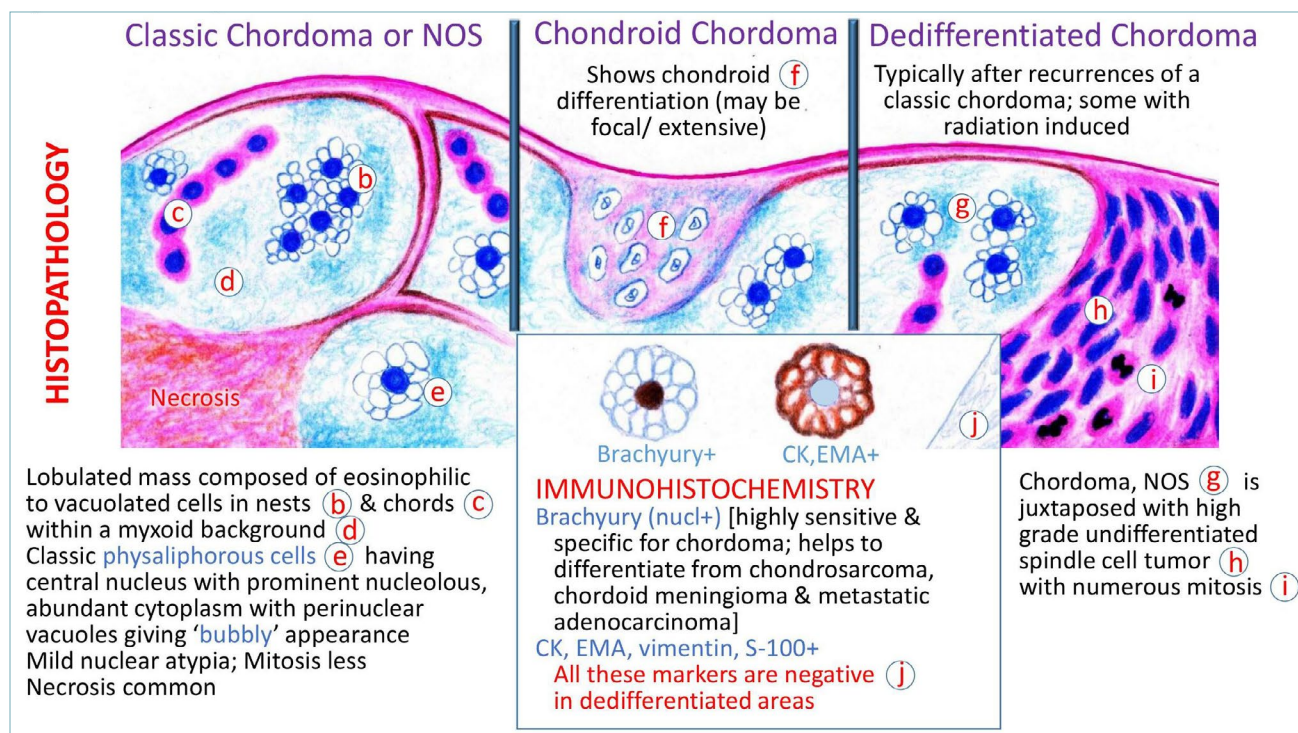
[www.facebook.com/AbhijitSurgPath](https://www.facebook.com/AbhijitSurgPath)) or Twitter channel (<https://twitter.com/AbhijitSurgPath>). Up to May 23, 2021, the Facebook and Twitter pages have respectively 4136 and 2213 followers. The infographics hosted on the Facebook page have generated a total of 3967 likes while those available on Twitter channel have produced a total of 1675 likes. Users from several countries approached the infographics, with India being the most involved.

## Infographics: impact on education

Infographic-based learning process can be a significant learning tool for the several domains and sub-domains of Pathology.

Teaching in morphological sciences aims to develop three types of knowledge: declarative (conceptual), procedural (strategic) and conditional<sup>5,21</sup>.

Declarative (conceptual) knowledge comprises the sum of information and data about a topic; it is basically “what you know about something”<sup>5,21</sup>. Within conceptual knowledge, infographics are intended to present large amounts of data in an easy and compact manner<sup>22</sup>. Infographics include technical terminology, specific details and elements which are the



**Figure 4.** Use of an infographic for a particular neoplastic entity, *chordoma and its variants: histopathological and immunohistochemical features.*

## PEMPHIGUS & DIFFERENTIALS

(Basic Morphology For Residents)

### PEMPHIGUS FOLIACEUS

- Subcorneal cleft
- More acantholytic cells in cleft
- Another superficial form *pemphigus erythematosus* may show similar presentation with denudation of corneal layer

### BULLOUS IMPETIGO

- Subcorneal cleft
- Caused by Group A streptococcus & staphylococcus
- More neutrophilic infiltrate in cleft

### SUBCORNEAL PUSTULAR DERMATOSIS (SPD)

- Subcorneal cleft
- Cleft contains neutrophil, eosinophil & few acantholytic cells
- Mild epidermal spongiosis with neutrophilic infiltrate
- Associated with *IgA paraproteinemia*

13.6.18@DrAbhijitDas

### STAPHYLOCOCCAL SCALDED SKIN SYNDROME (SSSS)

- Cleft in granular layer
- Few acantholytic cells

- Cleft in granular layer
- Suprabasal cleft
- Acantholytic cells

### PEMPHIGUS VULGARIS

- Suprabasal acantholysis
- Intact basal keratinocytes give 'tombstone' like appearance
- Acantholytic cells

### PARANEOPLASTIC PEMPHIGUS

- Features of pemphigus
- Interface dermatitis

### HERPES VIRUS INFECTION

- Acantholytic cells
- Necrotic keratinocytes
- Multinucleated cell with '3 M' (*multinucleation, moulding & margination* of chromatin)

### HAILEY HAILEY DISEASE

- *Benign familial pemphigus*
- Epithelial hyperplasia
- Dilapidated brick wall pattern
- Hair follicle not involved

### DARIER DISEASE

- *A/k/a Keratosis follicularis*
- Hyperkeratotic papule in follicular distribution
- Suprabasal acantholysis
- Corps ronds & grains

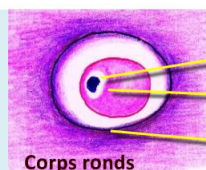
### GROVER DISEASE

- *Transient acantholytic dermatosis*
- May have small foci of acantholysis
- Darier or Hailey Hailey like pattern

**Acantholytic cell:** Rounded & condensed eosinophilic cytoplasm, enlarged nucleus with prominent nucleolus

### CORPS RONDS

- Cell with eccentric irregular nucleus with perinuclear halo; enclosed in a cystic space
- Usually seen at granular layer in *Darier disease (Keratosis follicularis)*



- Eccentric irregular nucleus
- Perinuclear halo
- Basophilic shell

**Figure 5.** Use of an infographic for a particular group of related diseases and differential diagnoses, *pemphigus* and its differentials.



basis of conceptual knowledge<sup>23</sup> being an incredibly efficient tool for it.

The procedural (strategic) knowledge is the one exercised in the performance of a task, it is basically 'how you know to do something'<sup>21</sup>. Within procedural knowledge, infographics increase the ability to interpret histopathological/immunohistochemical patterns and to correlate them with clinical problems. By outlining workflow interconnections in simple and concise graphical pathways, infographics can be of great help in the mental process of generating, formulating and achieving a correct diagnosis. They are oriented towards diagnostic problem solving skills, recapitulating subject-specific techniques and criteria to use appropriate procedures<sup>24</sup>.

The conditional knowledge regards the application of conceptual or strategic knowledge, it is basically 'when, where and why to use something'. In this context, infographics explore the interrelationships among the basic elements within a larger domain or sub-domain of Pathology, allowing the awareness of the rationale behind a diagnostic strategy<sup>24</sup>.

In recent years, in the field of Pathology, several profit and not-profit online resources have been developed to supplement traditional textbook materials and in the last months the global pandemic of SARS-CoV-2 has further strengthened this trend.

There is a wealth of web-based data for pathologists and different platforms providing them. Histopathology-related posts on Facebook, Twitter or Instagram contain images of histopathology slides with or without annotations, quizzes, detailed explanations and links to publications. Whole slide images can be visualized and navigated at any magnification<sup>25</sup>. Free of charge video-based tutorials and live stream lectures can be found on YouTube, Twitter<sup>26</sup> or dedicated "open-access" online platforms like pathCast<sup>27,28</sup>.

Pathology education performed by traditional methods is not equal worldwide, and the quality and extent of education may vary from country to country<sup>29</sup>, creating knowledge disparity between advantaged and less-advantaged countries. In this context, online resources and social media tools provide an alternative, free and less time-consuming method for pathologists to share their knowledge and experience with the next generation<sup>30</sup>.

Pathologists can share cases and respond to individual questions from other pathologists around the world, proposing a new model of teaching which is similar to that used in collegial discussions of cases at the multi-headed microscope, but on an amplified magnitude<sup>29</sup>. Accordingly, infographics entirely reproduce the traditional way of teaching in Pathology, by facilitating the understanding of complex subjects and translation of

what has been learned into the diagnostic practice. Moreover, they can be flexibly adapted to meet the needs of both trainees and practicing pathologists. In this sense, infographics emerge as integral part of continuing education in Pathology, mitigating the time-honored barriers of conventional learning systems. In conclusion, digitalization has given new life to an old teaching method, allowing its adaptation to social media platforms and its diffusion on a global scale.

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