Get your (visual) act together: Optimising the design of labels and arrows in medical illustrations

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Abstract
There is an enhanced communicating power of text when associated with visuals. This is a compelling argument for furnishing medical writers with basic knowledge on how to adapt and create simple figures. This article discusses tips on adding labels and arrows to pre-existing illustrations. These elements are fundamental components of scientific figures and should be consistent and designed from the start. By properly adjusting the alignment, style, and negative space of labels and arrows it is possible to convey further meaning and enhance the reading flow of figures.

The role of image in medical communication
Written and visual contents are synergetic vehicles for knowledge transmission.[1] A number of studies on medical communication and patient education have demonstrated the role of images, when in combination with text, as aids to:

a. **Preference and attention**: Readers are more likely to focus, choose to read, and spend more time reading written pieces that include related visuals.[2–5]
b. **Comprehension**: Readers, especially with lower education levels, are more likely to correctly answer questions about the content of a text that is illustrated with figures.[1]
c. **Scientific credibility**: The presence of an appropriate image has been associated with a higher number of readers agreeing with the conclusion of an article.[6]

Therefore, visuals should not be regarded as nice-to-have additions, but rather as pivotal components in communicating with all types of readers and across all platforms – from data-heavy, hard to digest materials, such as review articles for specialist audiences, to post-operative instruction leaflets that require compliance from lay patients.

For these reasons, even though visual communication is not the main focus of medical writers, there is a strong point in advocating for visual literacy as part of their basic and continuing education. The ability to develop engaging deliverables will ultimately translate into more competent and competitive professionals.

The visual literacy of a medical writer should range from the ability to properly use already-created images (such as stock illustrations), to being comfortable with visual concepts in order to work closely with medical illustrators to create tailor-made, scientifically accurate, and didactic figures.

The goal of this article is to furnish medical writers with easy tools that will allow them to independently adapt pre-existing images and create their own figures. The focus will be on simple, common, graphical elements, such as labels and arrows, which are the backbones of most medical visuals. Since figures should stand as intuitive as possible on their own, labels and arrows arise as essential components to convey further meaning; however, if poorly designed, they can greatly undermine the message of even the best quality illustrations.

Getting started
The content of this article is presented in the form of four case studies, covering simplified scenarios with different initial challenges. A sequential reading is recommended since topics complement each other.

Editing tools and previous considerations
In order to edit pre-existing images (e.g., illustrations, graphs, icons, diagrams, etc.), you can use vector graphics editing software, such as Adobe Illustrator, or an open-source option such as Inkscape. These programs, which may entail a steep learning curve, are not always a feasible option. Alternatively, Microsoft PowerPoint or Keynote, despite being not so user-friendly for this type of work, are accessible alternatives to consider.

Before starting to edit any pre-existing visual, make sure that you have the permission to do so. If the image is not from a public domain, and therefore is copyright protected, you will need to obtain permission to share it and adapt it – for example, check if the image is available under any Creative Commons licence.[7] In all cases, contact the author/owner of the image, whether the image is from an external source or created by an internal team member. Do not forget to formally acknowledge the original author in the final production.

Decoding the nomenclature
Throughout these four case studies, we will discuss several concepts related to labelling. A **call-out**, or **annotation**, is a label connected to the illustration by a line.[8] This line is called the **leader line**, and its ending is the **anchor point** (Figure 1).[8,9]

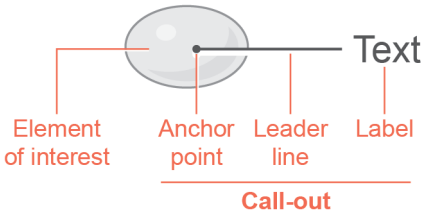
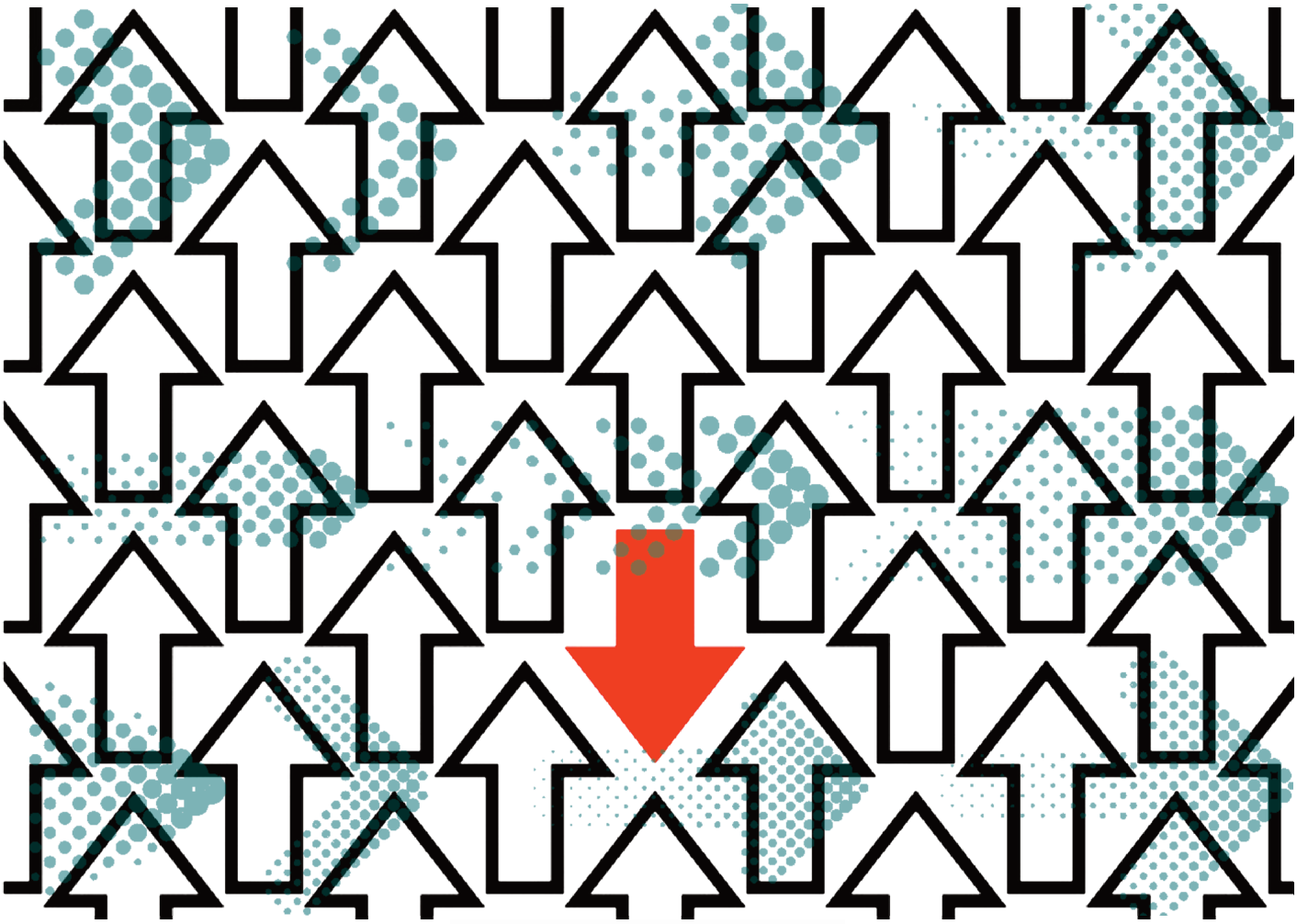


Figure 1. General structure of call-outs

General considerations about call-outs
Knowing labeling best practices is an important starting point to ensure a streamlined figure creation process.[8-11]

1. Ideally, labels should be designed from the start of the illustration work:
   a. If you are collaborating with a medical illustrator, make sure you inform them



about the exact structures to label. This will allow them to design and place regions of interest to better accommodate call-outs.

b. In the case of pre-existing images, create a text box for each label needed, so you can have an overview of the space they take collectively; then move them around until you reach an optimal organisation.

2. Avoid unnecessary labels. While it may be tempting to create figures as complete as possible, excessive information may be distracting to the readers. This holds true especially for non-specialist audiences who have less capacity to focus on the topic.[1] Furthermore, do not forget to pay attention to possible compliance requirements for specific labels.
3. Leader lines should be straight and solid. Lines with angles may apply in certain conditions (see Case study 2).
4. Leader lines must not cross, and labels must not overlap.
5. The typeface of the labels should be the same one used in the body copy. If the figure you are creating is part of a branded document for a specific client (e.g., a pharmaceutical company), make sure the style of the label (colour, width, typeface, etc.) follows the client's branding guidelines.
6. Design dark-coloured call-outs for white/lighter backgrounds, and white/light-coloured ones for darker backgrounds. Check to determine if the contrast between call-outs and background is strong enough. Temporarily converting your image into grayscale mode is a good way to evaluate this. Labels should usually have a neutral colour (e.g., dark grey, or white) unless guidelines express otherwise, or if using a neutral colour is confusing (e.g., Figure 1 has two labelling systems, so I decided to use an orange colour on the second system to emphasise that it is not part of the illustration).
7. Place final figures as close as possible to the text they relate to. Just as with labels, do not develop figures as afterthoughts; decide where they should be placed and make sure all text can be read at their final publication size.

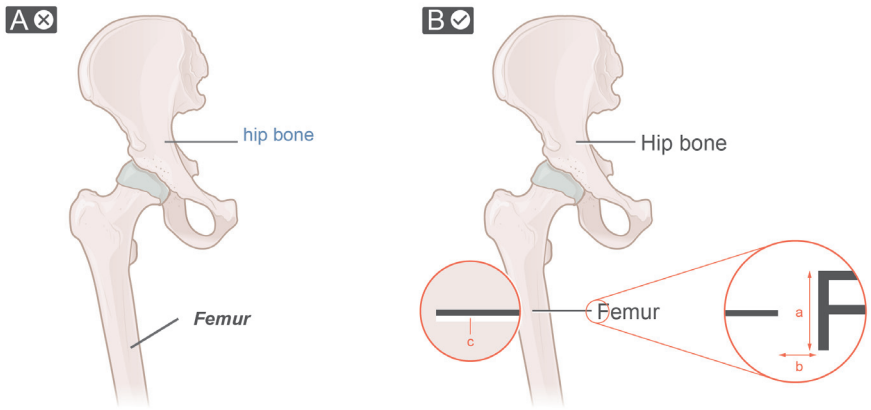


Figure 2. Anatomy of the hip joint
Image A. non-optimised figure; Image B. optimised figure;
a. height of the text; b. distance between the leader line and the label; c. leader line highlight.

Case study 1: General figure with a limited number of independent labels

In this first example, the goal is to label two bones in an anatomic illustration (Figure 2).

An important rule of thumb in illustration and design is that what is equal should stay equal. Hence, unless there is a reason to highlight a specific structure, all call-outs should be as cohesive as possible. You should use the same typeface, font size, font weight (e.g., thin, regular or bold), case (e.g., sentence or lower case), and colour in labels, and the same line thickness, colour and anchor point style in leader lines (Figure 2B). Start by designing a template call-out, and use it to recreate all others.

You should also ensure constancy in more subtle variables, such as the direction of leader lines and the spatial relationship between the start of the leader lines and the annotations. In Figure 2A, the two leader lines have different directions; Figure 2B was optimised by making these lines run parallel. This adjustment grants the image a flow that is very useful in guiding the eye from the illustration to the labels, and vice-versa. This effect is much more evident in images with a high number of labels that may overcrowd the image. In Case study 2, possible exceptions are discussed.

In Figure 2B, both leader lines start at the middle of the height of the label (a), and the distance between the leader lines and the labels is constant (b).

In images with few labels, if the organisation allows, it is advisable to place all call-outs on the same side; this will also reduce the space needed for the figure. Usually, I prefer to place the call-outs on the right side of the illustration, so readers can study the visuals first.

A final trick to ensure clear readability of leader lines throughout all its length is adding a small highlight just below it, in the same colour of the background.[12] In Figure 2B, we can witness how the addition of this highlight in white (label *c*) creates a visible contrast between the leader line and the bone underneath.

Case study 2: Detailed figure with a high number of related labels

This second example features the same illustration from the previous case study; however, the goal here is to label a higher number of structures, including some that are related (see the three bones that make up the hip). For the sake of simplification, the actual number of labels displayed is not high; in real scenarios, this could correspond to 15 or more labels in this type of illustrations.

Leader lines should cover as little as possible of the illustration and, whenever possible, end near the central point of the labelled region. In Figure 3A, the labels of *Femur* and *Ischium* cross several structures, and could easily be shifted to avoid overlapping important details. The label of *Femur* can be easily moved down; it could even be placed on the left side if we had a true higher density of call-outs, which would require more than one label to switch sides.

The leader line of *Ischium*, as a straight line, does not exhibit a placement where it is not crossing the pubis. A possible compromise solution would be to have the leader line arise as a straight horizontal line, and break it, after its central point, at a specific angle (135°, in this case) (Figure 3B). These angular leader lines should always have the same obtuse or right angle (e.g., 150°, 135°, 120° or 90°) to avoid disturbing the figure flow as much as possible.

Call-outs that stand close to each other

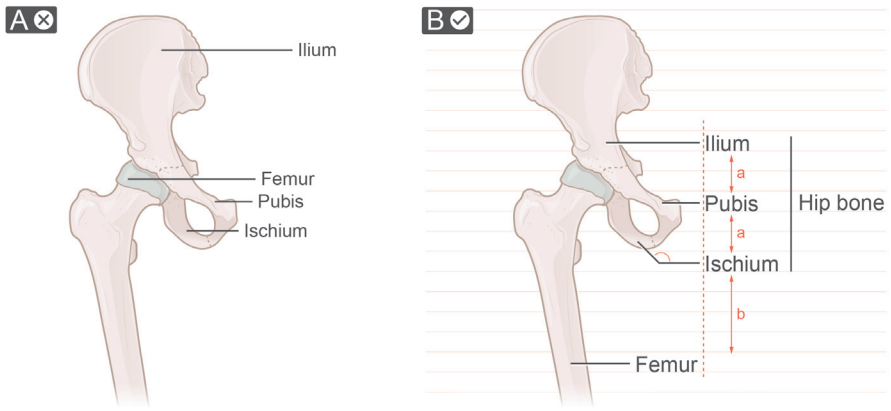


Figure 3. Bones of the hip joint
Image A. non-optimised figure; Image B. optimised figure;
a. distance between labels of the same group; b. distance between labels of different groups.

Labels and arrows arise as essential components to convey further meaning; however, if poorly designed, they can greatly undermine the message of even the best quality illustrations.

should be aligned to a vertical axis that runs along the start of their leader lines (Figure 3B) – this creates a more obvious organisation, guiding the eye through the listed labels. Labels further apart from each other do not need to be aligned, as this would create unnecessarily long leader lines (e.g., that would have happened with the label of *Femur* in Figure 3B). In those cases, you can opt for creating alignment groups based on location and eventually on relationships – in Figure 3B, all three parts of the hip bone are aligned with each other, but not with the label of *Femur*, thus reinforcing their different nature. If it is important to name the group of some labels, you can create a heading label (e.g., the label *Hip bone* in Figure 3B).

A final suggestion for figures with a high number of labels is to add a baseline grid along which you can place text (this grid will not show up in the final version). The equal spacings between labels create a certain rhythm and a cleaner and more appealing visual. You can make use of this grid to further emphasise the relationships between different groups (e.g., in Figure 3B, the distance *a* is shorter than *b*).[13] The drawback of a grid is that you are less flexible with the distribution of labels, therefore its need should be evaluated case by case. Nevertheless, clusters of labels that are close to each other, even if not related, should be spaced evenly.

Case study 3: Figure depicting a pathway/sequence of actions

In this third example, the goal is to label several elements in a depiction of the replication cycle of the hepatitis A virus.

In these types of figures, which have a precise directionality, arrows should guide readers through several steps. Therefore, opt for thicker, curved arrows that convey the movement/reading direction and are well integrated in the illustration. Make sure the end of an arrow is aligned with the start of the next one (e.g., in Figure 4B, it feels like it is almost a single arrow flowing from start to end).[14] Always assess if an arrow is needed and if you can merge several arrows together without compromising the message. Reducing the number of extra elements will make the image cleaner (e.g., in Figure 4B, there is no need for an arrow for each of the four elements that make up the virion). For the same reason, avoid very bright and colourful arrows, which compete with the salience of the illustration. Choose neutral colors such as dark grey for the arrows; alternatively, use background colours as shown in Figure 4B, where I used a dark blue that recedes against the warmer tones of the virus. Lastly, arrows should follow similar rules as leader lines, in terms of consistency and highlight (e.g., in Figure 4A, arrows with very different sizes and colours are not read as a single entity).

In visuals depicting sequences, you should also label relevant elements the first time they appear (e.g., in Figure 4A, it does not make sense to label *Virion* only at the last steps of the cycle).

In more complex illustrations, where individual elements are clearly discriminated or within an environment (e.g., inside a cell, tissue, or organ), leader lines may simply add excessive noise. In some cases, these are redundant, and you can omit them altogether without losing meaning (Figure 4B). When doing this, make sure legibility of the text is not compromised by a dark-coloured or busy background (e.g., the label of *Receptor* in Figure 4A), or by the text crossing multiple backgrounds (e.g., the label of *Viral genome* in the same figure).

Case study 4: Anchor points and coloured labels

This last case deals with the need to use different styles of anchor points and coloured labels.

In general, anchor points can be blunt (Figure 2B), or circular-shaped (Figure 5A overleaf). Circular bullet anchor points are especially useful if you are naming a specific small element (Figure 5A). When labelling two small elements that are slightly separated from each other, you may opt for a branched leader line with two anchor points (Figure 5B). When labelling three or more elements in close proximity, a single, wider circular anchor point without colour fill (more accurately, an anchor region) is an effective solution (Figure 5C). These approaches guarantee that all individual elements are included. Avoid arrowheads as anchor points, reserving them to convey movement only.

If the elements of interest are scattered throughout the illustration and have a specific main colour not present elsewhere, it may be easier to add a label in that same colour next to one of those elements (Figure 5D). This is particularly helpful when there is not a lot of space to add leader lines, so colour is used to create that connection. Make sure the coloured

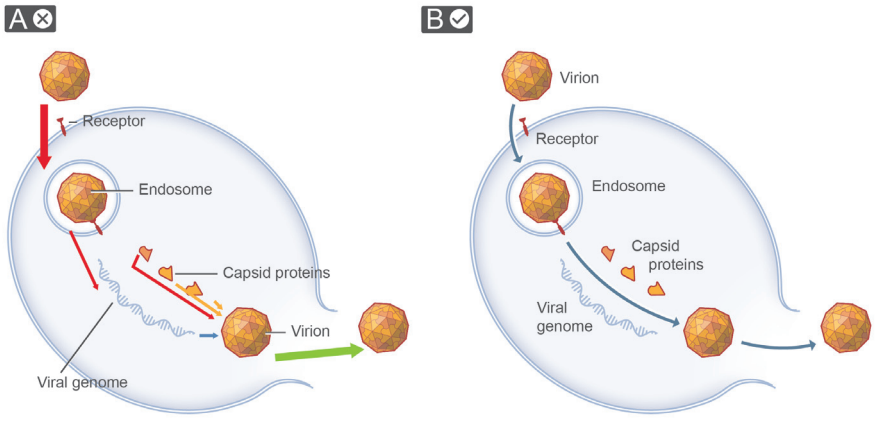


Figure 4. Generic replication cycle of hepatitis A virus (Picornavirus)
Image A. non-optimised figure; Image B. optimised figure

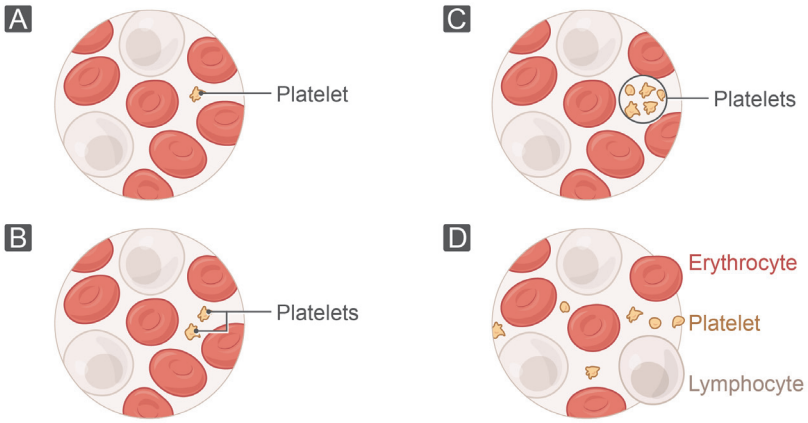


Figure 5. Different styles of anchor points and labels
A. leader line with circular/bullet anchor point; B. branched leader line with two anchor points; C. leader line with anchor region; D. coloured labels.

text is legible. A good rule of thumb is to always colour the call-out in a shade darker than that of the labelled element, to guarantee enough contrast with the background. This colour-labelling approach is not recommended if you need to label more than three structures.

Conclusion

This article aims to be a short introduction to image creation. Although it should not be required for medical writers to also be proficient illustrators or graphic designers, learning basic visual concepts may ease their work with images. It is in the best interest of medical communication that text and visuals be more and more consistently used in tandem.

Finally, the discussed case studies only included examples of medical illustrations. However, these tips can be applied to all sorts of visual materials such as graphs, diagrams, or flowcharts. Naturally, none of the above recommendations is set in stone. These tips should be adapted to each situation and, more often than not, a compromise is the best solution, especially in more complex figures.

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Conflicts of interest

The author declares no conflicts of interest.

References

1. Houts PS, Doak CC, Doak LG, Loscalzo MJ. The role of pictures in improving health communication: a review of research on attention, comprehension, recall, and adherence. Patient Educ Couns. 2006;61(2):173–90.
2. Holsanova J, Holmberg N, Holmqvist K. Reading information graphics: The role of spatial contiguity and dual attentional guidance. Appl Cognit Psychol. 2009;23(9):1215–26.
3. Holsanova J, Rahm H, Holmqvist K. Entry points and reading paths on newspaper spreads: comparing a semiotic analysis with eye-tracking measurements. Vis Commun. 2006;5(1):65–93.
4. Knobloch S, Hastall M, Zillmann D, Callison C. Imagery effects on the selective reading of Internet newsmagazines. Communic Res. 2003;30(1):3–29.
5. Delp C, Jones J. Communicating information to patients: the use of cartoon illustrations to improve comprehension of instructions. Academic Emergency Medicine. 1996;3(3):264–70.
6. McCabe DP, Castel AD. Seeing is believing: The effect of brain images on judgments of scientific reasoning. Cognition. 2008;107(1):343–52.
7. Creative Commons. 2019 [cited 2019 Dec 3]. Available from: https://creativecommons.org/about/.
8. Krzywinski M. Points of view: Labels and callouts. Nat Methods. 2013;10(4):275.
9. Vollick I, Vogel D, Agrawala M, Hertzmann A. Specifying label layout style by example. Proceedings of the 20th annual ACM Symposium on User Interface Software and Technology; 2007 Oct 7–10; Newport, Rhode Island, USA: ACM.
10. Oeltze-Jafra S, Preim B. Survey of labeling techniques in medical visualizations. Proceedings of the 4th Eurographics Workshop on Visual Computing for Biology and Medicine; 2014 Sep 3-5; Vienna, Austria: Eurographics Association.
11. Wood P. Scientific illustration: A guide to biological, zoological, and medical rendering techniques, design, printing, and display. 2nd ed. New York: John Wiley & Sons; 1994.
12. Sawchuk K, Woolridge N, Jenkinson J. Illustrating medicine: Line, luminance and the lessons from JCB Grant's Atlas of Anatomy (1943). Vis Commun. 2011;10(3):442–68.
13. Hunnicutt BJ, Krzywinski M. Points of view: Pathways. Nat Methods. 2016;13(1):5.
14. Wong B. Points of view: arrows. Nat Methods. 2011;8(9):701.

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