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# Creating Logical Flow When Writing Scientific Articles

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## ABSTRACT

Numerous guidelines on how to write a scientific article have been published. Many books and articles giving detailed instructions on how to develop a research question, perform a literature search, or design a study protocol are widely available. However, there are few guidelines on how to create logical flow when writing a scientific article. Logical flow is the key to achieving a smooth and orderly progression of ideas, sentences, paragraphs, and content towards a convincing conclusion. This article provides guidelines for creating logical flow when writing the text and main sections of a scientific article. The first step is creating a draft outline of the whole article. Once completed, the draft outline is developed into a single, coherent article that logically explains the study. Logical flow in the text is created by using precise and concise words, composing clear sentences, and connecting well-structured paragraphs. The use of transitions connects sentences and paragraphs, ensuring clarity and coherence when presenting academic arguments and conclusions. Logical flow in the main sections of a scientific article is achieved by presenting the whole story of the article sequentially in the introduction, methods, results, and discussion, focusing attention on the most important points in each section, and connecting all of these to the main purpose of the study.

**Keywords:** Logical Flow; Scientific Writing; Scientific Article; Transitions; Coherence; Clarity

## INTRODUCTION

Creating a logical flow in scientific articles can be developed and honed through practice and study. Although it can be overwhelming for writers to maintain a clear and organized content, there are guidelines on how to achieve clarity and brevity in scientific articles.<sup>1,2</sup> Keeping track of ideas and writing in a clear and concise manner will benefit readers. Articles with disorganized content from unrelated text and shifting ideas are difficult to comprehend. Moreover, disorganized content diverts attention from the main aim or focus of scientific articles.<sup>3</sup>

A well-written scientific article requires content proficiency and specialized writing skills to weave together terminology, language, facts, and ideas into a highly coherent information<sup>4</sup> devoid of repetitive language.<sup>5,6</sup> Clear and logical writing efficiently disseminates quality primary data and its analyses.<sup>7</sup>

There are numerous guidelines for writing a scientific article, often with specific instructions for developing a research question, performing a literature search, or designing a study protocol.<sup>8-10</sup> However, there is still a need for more journal articles detailing the sequential steps and providing published examples on how to achieve logical flow in scientific writing.<sup>8,11</sup> This article aims to provide specific guidelines to help authors create and maintain logical flow when writing the text and main sections of a scientific article. To illustrate key points, examples from peer-reviewed scientific articles in the healthcare field are provided.

## CHARACTERIZING POOR WRITING FLOW

Writing that lacks flow often has no logical argument or structure. It contains awkward phrasing and disjointed sentences which do not effectively lead to the next logical idea.<sup>12,13</sup> The sentences are fragmented, robotic, repetitive, or exaggerated,<sup>6</sup> with inconsistencies in tenses and use of language.<sup>14</sup> Missing transitions create disjointed phrases or paragraphs with little sense of continuity.<sup>14</sup> The writing shifts from one topic to another<sup>12</sup> and provides no evidence towards a valid conclusion.<sup>15</sup>

Poor writing flow weakens the unity and substance of a scientific article. Readers will not be able to adequately understand the research findings. They may be unable to experience a phenomenon or an event being described since they cannot comprehend the core message of the article. Often, this incomprehension is due to failure by the writer to communicate convincing conclusions and novelty.<sup>16</sup> Poor writing flow can create a sense of disconnect between the author and the reader,<sup>6</sup> and may stem from the author's lack of mastery of the content and weak writing skills.<sup>17,18</sup> Signs of weak writing may include the use of contracted or casual words, improper collocations, illegitimate or redundant text, long incomprehensible sentences, illogical argumentation, nominalization, and inappropriate hedges.<sup>19</sup> Thus, achieving clarity and logical flow when writing a scientific article is a crucial skill to acquire and deserves serious attention.

## EMPHASIZING LOGICAL FLOW IN SCIENTIFIC WRITING

Logical flow is the smooth and orderly progression of ideas, sentences, and paragraphs<sup>20,21</sup> without ambiguity or excessive transitioning.<sup>22,23</sup> Style, tone, viewpoint, and tenses<sup>14</sup> are consistent, even when using varied language,<sup>6</sup> word order, and length of sentences.<sup>3</sup> Logical flow allows readers to comprehend ideas with speed and ease.<sup>17</sup> The goal of any writer should be to present ideas consistently and coherently<sup>24</sup> without interruption of the writing flow, enabling readers to connect with the ideas.<sup>16</sup> The logical organization and linking<sup>25</sup> of ideas and content<sup>23</sup> require a detailed understanding and step-by-step presentation of the study's internal logic<sup>26</sup> to achieve credibility and a sound conclusion.<sup>27</sup>

## CREATING LOGICAL FLOW IN ARTICLE TEXT

Creating logical flow in the text requires the use of concise words, clear sentences, and well-structured paragraphs. To maintain overall coherence, sentences and paragraphs should be connected by appropriate transitions. This would ensure sound arguments with logical conclusions.<sup>17,28</sup>

**Table 1.** Commonly used phrases, their shortened forms, and writing examples<sup>30</sup>

Phrase	Shortened form	Writing example (shortened form in bold font)
After the operation	Postoperatively	The patient was in pain <b>postoperatively</b> .
A large number of	Many	<b>Many</b> students were tested for the virus.
A number of	Several	<b>Several</b> participants dropped out of the study.
Are in agreement	Agree	These results <b>agree</b> with previous findings.
Are indicative of	Indicate	The pathological findings <b>indicate</b> metastasis.
Are found to be	Are	The newly developed drugs <b>are</b> effective.
At a rapid rate	Rapidly	The infection is spreading <b>rapidly</b> .
At present	Now	A new therapeutic approach is being tested <b>now</b> .
At the present time	Presently	<b>Presently</b> , reports on this topic are scarce.
As a matter of fact	In fact	<b>In fact</b> , a recent study supports our findings.
Because of the fact that	Because	<b>Because</b> he received the vaccine, he recovered.
Before the operation	Preoperatively	Ultrasound was performed <b>preoperatively</b> .
By means of	By	The tumor was diagnosed <b>by</b> radiography.
For the purpose of	For	The intervention was conducted <b>for</b> education.
Have the ability to	Can	Students <b>can</b> plan their own presentations.
It is possible that	Possibly	<b>Possibly</b> , there was bias in participant selection.
In spite of the fact that	Although	<b>Although</b> the drug is under trial, it was administered to the patient.
In the final analysis	Finally	<b>Finally</b> , TBL was more effective than lecturing.
In the event that	If	<b>If</b> apoptosis is induced, the drug is effective.
In order to	To	Randomization was performed <b>to</b> avoid bias.
In case of	For	<b>For</b> the control group, the placebo was given.
In the future	Soon	Follow-up studies will be conducted <b>soon</b> .
It appears that	Apparently	<b>Apparently</b> , the sample size was small.
Prior to	Before	Patient consent was obtained <b>before</b> the study.
The majority of	Most	<b>Most</b> of the patients were early adolescents.
With reference to	Regarding	<b>Regarding</b> author ID, ORCID was used.
With the exception of	Except	All cell types were stained <b>except</b> fibroblasts.

### Writing concise words

To be concise, writers should choose brief but comprehensive words that most effectively communicate findings. Brevity in writing involves pruning redundant words or overstated ideas and directly presenting the message<sup>17</sup> thus maintaining reader interest.<sup>23</sup> Use of correct terminology or specialized vocabulary (i.e., discipline-specific terminology), general academic vocabulary, and more formal instead of colloquial words would help in concise writing.<sup>29</sup> When faced with several options, the word that best conveys the meaning of a phrase should be used. Choosing precise words ensures clarity of the text without superfluities (Table 1).

### Composing clear sentences

The clarity of sentences determines the readability and comprehension of an article. To write clear sentences, focus on one topic.<sup>31</sup> Without sacrificing clarity, remove redundancy and minimize fragments in the middle of sentences (e.g., which, that, although, where, and when). Use less modifiers (e.g., very, basically, generally, specifically) and avoid unnecessary clauses beginning with that, who, and which.

It is advisable to vary the types, lengths, and start of sentences. Write parallel sentences and combine sentences with the same ideas. Tie ideas together in sentences by using pronouns, repeating keywords, and inserting transitional words or phrases (e.g., therefore, however, or consequently).<sup>13</sup> Highlight content using short and declarative sentences (i.e., 20–25 words maximum length)<sup>5</sup> or sentences with a maximum of three lines.<sup>3,32</sup>

**Box 1.** Examples of long or unclear sentences made shorter and clearer (revised parts in bold font)

- Respiratory medicine  
*Original sentence (20 words):* A 55-year-old woman was admitted in a hospital complaining of experiencing 10 minutes of chest pain after smoking a cigarette.  
*Shorter and clearer sentence (15 words):* A 55-year-old woman was admitted **for** chest pain **she felt for 10 minutes** after smoking.
- Cardiology  
*Original sentence (18 words):* The coronary spasm is specifically an important differential diagnosis of the causes of the chest pain in patients.  
*Shorter and clearer sentence (10 words):* Coronary spasm **is an** important differential diagnosis of **chest pain**.
- Oncology  
*Original sentence (20 words):* Our progress of chemotherapy to the treatment of unresectable colorectal cancer has provided many patients with a prolonged survival period.  
*Shorter and clearer sentence (11 words):* **Progress in** chemotherapy **for** unresectable colorectal cancer has prolonged **patient** survival.
- Pathology  
*Original sentence (29 words):* The histological types were distributed and classified as adenocarcinoma in 51 cases, squamous cell carcinoma in 24 cases, large cell carcinoma in 15 cases, and carcinoid in 10 cases.  
*Shorter and clearer sentence (17 words):* The histological types **were adenocarcinoma (n = 51), squamous cell carcinoma (n = 24), large cell carcinoma (n = 15), and carcinoid (n = 10).**
- Genetics  
*Original sentence (28 words):* An abnormal noradrenaline transporter gene has been reported by other studies in a part of the disease, and the pathological conditions based in genetic abnormality are being suspected.  
*Shorter and clearer sentence (18 words):* An abnormal noradrenaline transporter gene **reportedly plays a role in** the disease **pathogenesis, thus** genetic abnormality **is** suspected.
- Nursing  
*Original sentence (40 words):* Among the factors which have effects on quality of life, the positive factors were Spousal Support and the negative factors were Distress and infertility period, and of those factors, the most influential negative factor on quality of life was Distress.  
*Shorter and clearer sentence (27 words):* Among factors **affecting** quality of life, the positive **factor was spousal support** and the negative factors were **distress** and infertility period, **with distress being the strongest** factor.
- Nursing  
*Original sentence (30 words):* A social support has been specifically described as having the very function of buffering life when there is a stressfull life events and is related to promoting our very well-being.  
*Shorter and clearer sentence (14 words):* **Social** support has **a buffering** function **against stressful** life events and **promotes** our well-being.
- Science/medicine  
*Original sentence (9 words):* It is a method that is often carried out.  
*Shorter and clearer sentence (5 words):* **This** method is often **performed**.
- Science/medicine  
*Original sentence (10 words):* This is a procedure that is recommended by the FDA.  
*Shorter and clearer sentence (7 words):* This **procedure** is recommended by the FDA.
- Science/medicine  
*Original sentence (6 words):* These data are preliminary in nature.  
*Shorter and clearer sentence (4 words):* These data are **preliminary**.

**Constructing well-structured paragraphs**

Constructing well-structured paragraphs involves focusing on the main idea of each paragraph and ensuring unity, coherence, and evidenced-based explanations of the idea.<sup>33</sup>

The first sentence in a paragraph is the topic sentence.<sup>21,31</sup> It introduces the main idea of the paragraph<sup>31</sup> and gives a clue to its contents<sup>21,23,33</sup> and their interpretation.<sup>11,16</sup> A well-written topic sentence has a specific assertion.<sup>34</sup> It creates a framework for connecting the supporting ideas in the paragraph.<sup>35</sup>

The middle sentences corroborate the main idea in the topic sentence.<sup>31</sup> These sentences provide explanations, definitions, comments, evidence, and examples to illustrate important points.<sup>21</sup>

The last sentence summarizes the information in the middle sentences.<sup>31</sup> It re-emphasizes the topic sentence and acts as a transition sentence to the next paragraph.<sup>31,32,36</sup>

When writing paragraphs, write facts and avoid lengthy generalizations.<sup>24</sup> Preferably, compose sentences of about 20 words<sup>31</sup> and relate all sentences to the main idea. Make each sentence flow from the previous sentence while maintaining a link to the topic sentence. Maintain the “one idea-one paragraph” principle and build paragraphs based on deductive reasoning.<sup>33</sup> It may help to use a sentence pattern to achieve a linear logic,<sup>15</sup> as an important feature of the text is a linear flow of argumentation wherein the theme of the previous sentence becomes a topic of the following sentence.<sup>29</sup>

Overall, successful flow in paragraphs is determined by selecting unified ideas that support the main idea in each paragraph, and then creating effective connections between paragraphs.<sup>6</sup> This sequence in paragraphs builds a compelling argument with logical flow<sup>14</sup> (Fig. 1).

### Connecting sentences and paragraphs using transitions

Transitions are words, phrases, or sentences that connect consecutive sentences or paragraphs<sup>37,38</sup> and enable readers to follow the logical flow of the message.<sup>39</sup> Transitions may be grouped into three encompassing categories as to how these create logical flow in terms of language, role, and function.

In terms of language, Philbrook<sup>37</sup> classified transitions into transitional words, transitional sentences, and transitional paragraphs as summarized below. Some examples from published articles are also provided.

Transitional words indicate the relationship between each idea (e.g., additionally, as well as, conversely, otherwise).

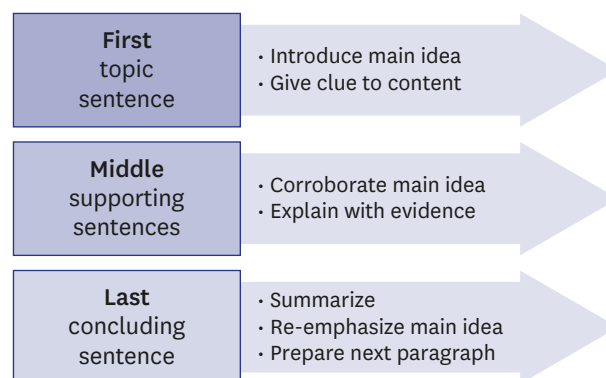


Fig. 1. Construction of a well-structured paragraph.

**Box 2.** Examples of transitional words (in bold font) from published articles

“One of the most worrying features of COVID-19 is a phenomenon known as the “cytokine storm”, which is a rapid overreaction of the immune system. **Additionally**, coagulation abnormalities, thrombocytopenia and digestive symptoms, including anorexia, vomiting, and diarrhea, are often observed in critically ill patients with COVID-19.”<sup>40</sup>

“We describe the validity of measures and their potential biases, **as well as** the scientific methods used in this field.”<sup>41</sup>

“Although obesity provides an advantage in cold conditions it **conversely** impedes heat loss and makes obese people susceptible to heat stress more than lean individuals.”<sup>42</sup>

“There are several instances where tele-physiotherapy may be an appropriate form of primary care, including the early management of acute pain, which may **otherwise** become chronic.”<sup>43</sup>

Transitional sentences connect one paragraph to another. These sentences mention the topic of the previous paragraph, and establish a connection between that previous topic and the next topic.

**Box 3.** Example of transitional sentence (in bold font) (field: breast cancer)<sup>44</sup>

First paragraph	<p>Topic sentence →</p> <ul style="list-style-type: none"> <li>• Talks about HER2 and focuses on HER2 heterogeneity (underlined)</li> </ul>	<p>“<b>HER2 is also overexpressed in other types of cancer besides breast cancer.</b> In patients with HER2-amplified esophageal adenocarcinomas, heterogeneous HER2 amplification was observed in 17%, and the presence of <u>HER2 heterogeneity</u> was independently associated with worse disease-specific survival and overall survival (OS).<sup>16</sup></p>
Second paragraph	<p>Transitional sentence →</p> <ul style="list-style-type: none"> <li>• Connects the first paragraph to the second paragraph</li> <li>• Mentions the first paragraph topic: HER2 heterogeneity</li> <li>• Establishes a connection to the next topic: association of HER2 heterogeneity with malignant potential (underlined)</li> </ul>	<p><b>However, it remains unknown why HER2 heterogeneity is associated with malignant potential.</b> Molecular profiling classified breast cancer into 6 intrinsic subtypes. Estrogen receptor/progesterone receptor/HER2 positivity on IHC staining is thought to surrogate the intrinsic subtypes. However, different intrinsic subtypes are mixed in HER2-positive breast cancer, that is, 51% showed HER2-enriched type, 28% showed luminal type, and 21% showed the typical intrinsic subtypes for triple negative breast cancer such as basal type, claudin-low type, and normal-like type.<sup>17</sup> This suggests that the triple negative features are present in some HER2-positive breast cancers, which may be associated with the <u>malignant potential</u>. In the present study, mice injected with heterogeneous-HER2 cells (HER2-60) showed a shorter survival than mice injected with triple negative cells (231-Luc). <u>Taken together, the interaction between HER2-positive cells and HER2-negative cells appear to accelerate the malignant potential.</u>”</p>

**Box 4.** Example of transitional sentence (in bold font) (field: cardiac surgery)<sup>45</sup>

First paragraph	<p>Topic sentence →</p> <ul style="list-style-type: none"> <li>• Focuses on cardiac tumors and composition (underlined)</li> </ul>	<p>“<b>Primary cardiac tumors are rare; 75% of them are benign neoplasms, which may occur at any age and in any part of the heart.</b><sup>4</sup> In particular, <u>hemangiomas</u> account for 5% to 10% of these benign tumors.<sup>5</sup></p>
Second paragraph	<p>Transitional sentence →</p> <ul style="list-style-type: none"> <li>• Connects the first paragraph to the second paragraph by referring to cardiac tumor</li> <li>• Then elaborates on the cardiac tumor in the patient as being a benign hemangioma, and on hemangiomas (underlined)</li> </ul>	<p><b>In the patient described here, the cardiac tumor was initially thought to be a malignant metastatic tumor because of his history of lung metastasis from rectal cancer, which was treated by surgical resection.</b> However, we definitively diagnosed the cardiac tumor as a <u>benign cardiac hemangioma</u> by histopathologic examination. Most <u>hemangiomas</u> are relatively small subendocardial nodules (2.0 to 3.5 cm), which may be mostly solitary.<sup>6</sup> In our patient, however, the tumor was a continuous bilocular mass whose length reached up to 4.85 cm.”</p>

Transitional paragraphs serve as introductory paragraphs to describe the large section and transition readers to new information.

Box 5. Example of a transitional paragraph (in bold font) (field: gastroenterology)<sup>46</sup>

First paragraph	<p><b>Transitional paragraph</b></p> <ul style="list-style-type: none"> <li>• Introduces main topic: EUS-FNA</li> <li>• Emphasizes the importance of acquisition of large amount of core tissue and its histological assessment</li> </ul>	<p>“EUS-FNA with cytology has been used as a safe and accurate procedure for establishing a pathological diagnosis of intraluminal or extraluminal lesions since the first report by Vilmann et al.<sup>10</sup> in 1992. Although the high accuracy of EUS-FNA with cytology has been reported, it remains imperfect because of the limited pathological evaluation. <b>Recently, the acquisition of a large amount of core tissue and its histological assessment has become increasingly important to further improve the diagnostic yield of EUS-FNA and to establish an accurate diagnosis with fewer FNA passes.</b></p>
Second paragraph	<p>The first paragraph transitions readers to new information on the advantages of acquisition of large amount of core tissue in the succeeding paragraphs: <u>First advantage:</u> Enables MOSE (underlined)</p>	<p><u>The acquisition of a large amount of histological core tissue has some advantages. First, it enables macroscopic on site evaluation (MOSE).</u> Although many reports have suggested that rapid on site evaluation (ROSE) improved the diagnostic accuracy and limited the number of FNA passes required to establish a diagnosis,<sup>11-13</sup> the presence of a cytopathologist is not routinely guaranteed because of labor shortages in many centers and even at high volume centers. Iwashita et al. reported the efficacy of MOSE as an alternative to ROSE.<sup>14</sup> In MOSE, the number of FNA passes is decided on the basis of the macroscopically visible core, which is defined as whitish or yellow pieces of obtained tissue with an apparent bulk. MOSE is useful for estimating specimen adequacy and for reducing the number of FNA passes without the need for ROSE if a visible amount of histological core tissue is obtained.</p>
Third paragraph	<p><u>Second advantage:</u> Enables pathological diagnosis of neoplasm (underlined)</p>	<p><u>Second,</u> regarding EUS-FNA for solid pancreatic masses, the cytological or histological assessment of a small tissue specimen is generally adequate for the diagnosis of benign or malignant tumors. However, it is occasionally difficult to distinguish between malignancy and chronic pancreatitis or autoimmune pancreatitis, including atypical cells with stromal fibrosis, by cytology or histology of a cell cluster, especially for pathologists who do not specialize in biliopancreatic diseases. <u>A large amount of core tissue including an increase in invasive atypical cells with desmoplastic fibrosis readily enables a pathologist to make a pathological diagnosis of neoplasm.</u></p>
Fourth paragraph	<p><u>Third advantage:</u> Enables H&amp;E, IHC, and flow cytometric or cytogenetic examinations (underlined)</p>	<p><u>Third,</u> to make an accurate pathological diagnosis of nonepithelial tumors or inflammatory benign diseases such as gastrointestinal stromal tumor, malignant lymphoma, or autoimmune pancreatitis, tissue architecture evaluation and immunohistochemical staining assessment are required.<sup>15,16</sup> <u>A large amount of core tissue enables not only hematoxylin and eosin staining but also additional immunohistochemical examinations or flow cytometric and cytogenetic assessments.</u></p>
Fifth paragraph	<p><u>Fourth advantage:</u> Possibility of personalized medical treatment according to individualized molecular profiling (underlined)</p>	<p><u>Fourth,</u> current advances in basic medical science have enabled the development and clinical application of molecular targeting and the assessment of molecular markers or DNA profiling, indicating resistance and the effects of anticancer chemotherapy or patient prognosis.<sup>17</sup> A small amount of obtained tissue is not suitable for the assessment of molecular expression by immunohistochemical staining or DNA sequencing. <u>If personalized medical treatment according to individualized molecular profiling will be developed in the future, the importance of accurately obtaining a sufficiently large amount of core tissue by EUS-FNA in 1 session would increase.”</u></p>

In terms of role, wordvice.com classified transitions into four types<sup>47</sup>: additive, adversative, causal, and sequential transitions, as summarized below. Examples from published articles are also provided.

Additive transitions indicate the addition of new information (e.g., furthermore, in addition to), highlight information (e.g., particularly, to illustrate), refer to something (e.g., regarding, with regards to), show similarity (e.g., similarly, in the same way), and clarify important information (e.g., specifically, this means that).<sup>47</sup>

**Box 6. Example of an additive transition (in bold font)**

“Inflammation markers have been proposed as prognostic markers for the development of T2DM and its complications. **Furthermore**, modulation of the inflammatory process may offer future treatment strategies for T2DM.”<sup>48</sup>

Adversative transitions distinguish facts, arguments, and other information by contrasting and showing differences (e.g., however, on the other hand), distinguishing/emphasizing points (e.g., primarily, most importantly), conceding points (e.g., nevertheless, in spite of), dismissing an argument or assertion (e.g., regardless of, at any rate), and indicating an alternative (e.g., instead of, at least).<sup>47</sup>

**Box 7. Example of an adversative transition (in bold font)**

“Evidence of the relationship between temperature during pregnancy and human embryo mortality is limited. **Most importantly**, the literature lacks causal estimations and studies on early pregnancy losses.”<sup>49</sup>

Causal transitions show the cause or reason (e.g., since, owing to), explain the conditions (e.g., unless, in the event that), show the effects/results (e.g., therefore, as a result), show the purpose (to, for the purpose), and highlight the importance of circumstances (e.g., otherwise, under these circumstances). These transitions are used after establishing an important point or for exploring hypothetical relationships.<sup>47</sup>

**Box 8. Example of a causal transition (in bold font)**

“Transplants have become common with excellent patient and graft outcomes **owing to** advances in surgical technique, immunosuppression, and antimicrobial prophylaxis.”<sup>50</sup>

Sequential transitions organize information by number (e.g., firstly, first of all), show continuation in thought or action (e.g., subsequently, after this), refer to previously mentioned information (e.g., summarizing, as mentioned above), indicate digressions (e.g., incidentally, returning to the subject), and make a conclusion (e.g., overall, in conclusion). Sequential transitions create structure to help understand the logical development of the methods, results, and analysis.<sup>47</sup>

**Box 9. Example of a sequential transition (in bold font)**

“A serine/threonine protein phosphatase (PPs) activity assay was employed to monitor PPs activity. **Subsequently**, flow cytometry was used to monitor chemokines levels in plasma samples from individuals with cognitive deficits.”<sup>51</sup>



In terms of function, some examples are as follows<sup>6</sup>: to express agreement or reinforcement (e.g., also, in the same way, likewise); to express alternatives or contrarian evidence (e.g., in contrast, on the contrary, in reality, although, instead, rather); to present effects or consequences (e.g., as a result, for this reason, thus, consequently, therefore, accordingly); to introduce examples or to emphasize importance (e.g., for example, for instance, to demonstrate, as an illustration, notably, namely, indeed, certainly, such as, in fact); to conclude, summarize, or restate ideas (e.g., all things considered, as shown, given these points, in short, to summarize, in essence, altogether, to sum up, in any case, ultimately); and to hedge (e.g., possibly, this suggests, it may seem, perhaps, we may conclude).<sup>12</sup>

**Box 10.** Example of a transition in terms of function (in bold font)

“Elderly population and age-related diseases are on the rise. **On the contrary**, aging studies are technically hard to conduct, because they require elderly animals, the maintenance of which requires ample effort and is expensive.”<sup>52</sup>

Altogether, transitions link ideas, sentences, and paragraphs<sup>6,12,17,23</sup> and create logical connections that help deliver the argument, present information, and enhance coherence and flow.<sup>4</sup>

### Ensuring sound argument to achieve logical connections

Effective transitions provide connection, clarity, and logical flow to ideas and arguments. However, they cannot be used solely as a substitute for ideas and content. Ideas must first be established in a simple and orderly way—through clear sentences and well-structured paragraphs. Afterwards, appropriate transitions should be used to connect individual sentences and consecutive paragraphs and show how these are related.<sup>53</sup> After using transitions to develop the sentences and paragraphs fully, integrate the topic sentence, lines of evidence, and other attributes of each paragraph to ensure the logical movement of an argument through the text.<sup>35</sup> This entails clearly stating the thesis statement and supporting it with thoroughly analyzed evidence. It also implies the logical discussion, exploration, explanation, reflection, summary, synthesis, and participation in the whole intellectual process of scientific writing.<sup>34</sup>

### Maintaining overall coherence

Coherence in scientific articles means that the words, clauses, sentences, and paragraphs are clearly related to one another and to the main topic of the article.<sup>12</sup> It is achieved when the ideas flow precisely and logically.<sup>54</sup> Scientific articles must maintain both logical coherence and lexical coherence. Logical coherence is achieved by the orderly placement of the main ideas and their supporting details.<sup>55</sup> Lexical coherence is attained by the appropriate use of words that help readers navigate the article to its main message.<sup>34</sup> Coherence can be maintained by repetition of keywords or by referring to the main idea of the previous paragraph before introducing the current paragraph.<sup>56</sup>

## ESTABLISHING LOGICAL FLOW IN THE ARTICLE AND ITS MAIN SECTIONS

After creating logical flow in the article text, the next step is to present the whole story of the article by establishing logical flow in its main sections: introduction, methods, results, and

discussion (i.e., IMRAD)<sup>5</sup> and avoiding language errors.<sup>57</sup> The focus is on the most important points and the order in which they are presented.<sup>23</sup> Regarding order, the rhetorical (move-step) model can be applied to empirical research articles to establish logical flow.<sup>29</sup>

### Creating the introduction section

The introduction section describes how the study adds new knowledge that addresses an important question.<sup>32</sup> Create logical flow in the introduction section by making three paragraphs.<sup>7</sup> In the first paragraph, describe the scope, nature, or magnitude of the problem being addressed. In the second paragraph, clearly articulate why a better understanding of this problem is useful. Include current knowledge and previous studies' limitations. In the third paragraph, state the aims and briefly explain what the study adds to the scientific knowledge base.<sup>5,7</sup>

### Constructing the methods section

The methods section provides information necessary for recreating the analysis given the same data. To create logical flow in the methods section, describe exactly how the data relevant to the study's objectives or purpose were collected, organized, and analyzed.<sup>5</sup> Describe the study design first, followed by the setting, subjects, data collection methods, and finally data analysis.<sup>7</sup> Refrain from writing partial results in the methods section.<sup>11</sup>

### Describing the results section

To logically describe the results section, draft the figures first to reveal data trends or relationships, and then the tables to show specific data points. Use these figures and tables as supporting evidence when describing the main outcome. Next, identify the figures and tables that best describe the findings. Then, write a sentence summarizing each figure and table.<sup>5</sup> Afterwards, write the text with a sequential discussion and a brief statement of conclusion for each figure and table. Interpret the results in detail in the discussion section.<sup>7,32</sup> Present the data efficiently and logically by focusing on how they relate to the main purpose or objectives of the study.<sup>11</sup>

### Organizing the discussion section

The discussion section is the keystone of a scientific article. Write the discussion section with precision, brevity and without ambiguity.<sup>58</sup> Unify ideas to clearly communicate the main message of the study. Observe brevity but do not sacrifice logic and clarity.<sup>11</sup> To achieve logical flow, aim to write the discussion in four to six paragraphs.

In the first paragraph, briefly restate what the study's purpose or objectives are. Then, highlight the key results<sup>59</sup> with a focus on how these met the study's aims.<sup>7</sup>

In the second, third, and fourth paragraphs, contextualize each key result with the relevant literature in separate paragraphs. When interpreting key results, emphasize their uniqueness, usefulness, and relevance. Then, expand the interpretation by assessing what can be achieved now with these new data or what gap in previous knowledge could be filled.<sup>32</sup> Finally, frame the results by describing how the study adds to the literature.<sup>59</sup> Follow the same order of the methods and results when discussing each key result.<sup>7</sup>

In the fifth paragraph, state the limitations in the methodology, results, or manuscript organization.<sup>59</sup> Then, list the strengths and weaknesses of the study. Finally, describe the needs and offer perspectives for future studies.<sup>7</sup>

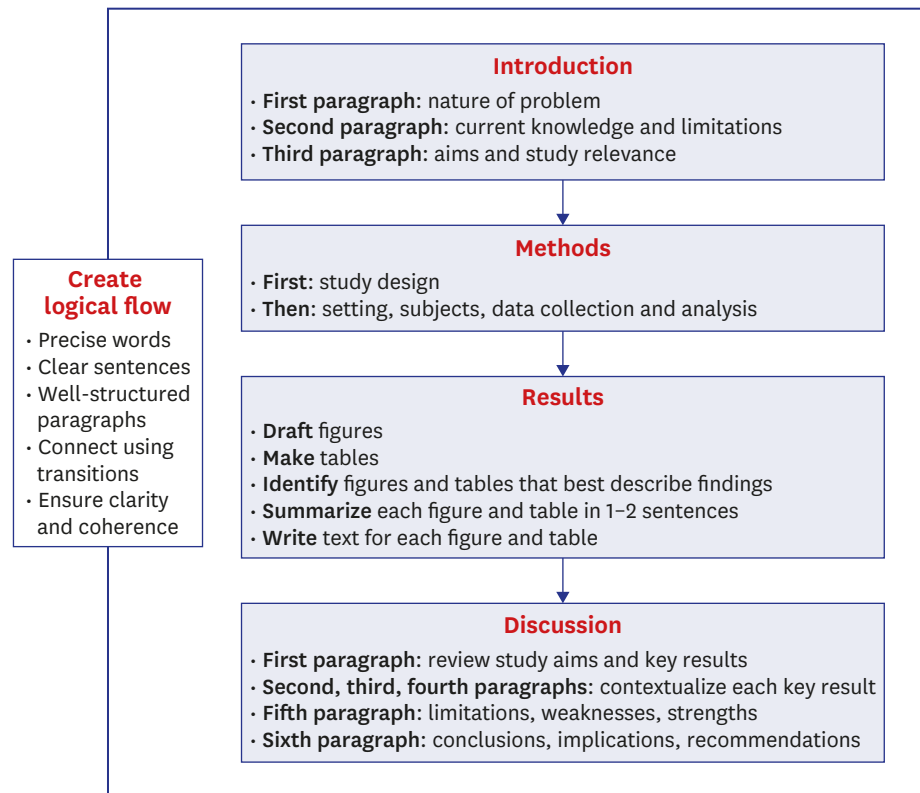


Fig. 2. Establishing logical flow in a scientific article and its main sections.

In the sixth paragraph, state the conclusions and implications of the study. Then, provide recommendations for further research into the remaining gaps. Finally, make suggestions regarding the changes needed.<sup>5</sup>

### Establishing logical flow in the whole article

To establish logical flow and readability of the whole article, write short, simple, clear, concise, and coherent sentences.<sup>60</sup> Choose and correctly place keywords and transitions to establish a link between sentences and between paragraphs. Be mindful of the logical interrelationship between the first and final parts, together with the supporting middle parts.<sup>61</sup> This means that the first (topic), middle, and final sentences in paragraphs are logically connected, and that the first, middle, and final paragraphs in an article are logically interrelated<sup>61</sup> (Fig. 2).

## CONCLUSION

Creating logical flow is a crucial but often neglected component in writing a scientific article. Logical flow in the text and main sections of a scientific article enhances the presentation of key results and the whole story of the article with clarity and depth. It allows the reader to grasp the key message of the article with speed and ease, facilitating the valuable exchange of ideas.

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