Writing the Biomedical Manuscript:

Essentials of Good Writing

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A Recognized Problem

“There is no form of prose more difficult to understand and more tedious to read than the average scientific paper!”

-Dr. Francis Crick, 1994
The Astonishing Hypothesis
An Editor’s Warning

“Poor writing is likely to annoy reviewers and decrease the author’s chance of publication recommendation”

Bordage, G: Peer Reviewer, University of Illinois at Chicago: 
Academic Med 76(9), 2001
An Author’s Warning

“Some authors believe that they must impress the reader (and the editor) with mastery and erudation of multisyllabic words in order for their work to be given attention.”

“Say what you mean, mean what you say, and don’t use big words”

Methods are Critical: Editors’ Responses

How frequently do Editors encounter manuscript problems?

- Poorly written, excessive jargon
- Inadequate/inappropriate presentation
- Poor description of design
- Excessive zeal and self promotion
- Rationale confused, contradictory
- Essential data omitted, ignored
- Boring
- Important work of others ignored

Byrne DW, Publishing Medical Research Papers, Williams and Wilkins, 1998
In 1953, Crick Writes:

- We wish to suggest a structure for the salt of deoxyribose nucleic acid (DNA). This structure has novel features, which are of considerable biological interest.

- A structure for nucleic acid has already been proposed by Pauling and Corey\(^1\). The model consists of three intertwined chains, with the phosphates near the fibre axis, and the bases on the outside. In our opinion, this structure is unsatisfactory for two reasons:
  
  1. We believe that the material which gives the x-ray diagrams is the salt, not the free acid. Without the acidic hydrogen atoms, it is not clear what forces would hold the structure together, especially as the negatively charged phosphates near the axis will repel each other.
  
  2. Some of the van der Waals distances appear to be too small.
In order to determine if the expertise in the attribution of emotion from basic facial expressions in high functioning individuals with autism spectrum disorder (ASD) is supported by the same reported brain regions of interest (ROI) as the regions supported by typically developing individuals, the present study employed functional MRI scanning technology acquired from 14 males and 32 females with the specified disorder while performing emotion-matched and emotional label linguistic and also control tasks. The accuracy, response time, and average activation was acquired and measured in the amygdala and other important ROIs.
Why Does Grammar Matter?

- Your paper must convey clearly and accurately your purpose, method, result, and conclusion.
- Free of ambiguity and misinterpretation.
- The scientific community is world-wide.
- If English is sloppy, ungrammatical, ambiguous in meaning, your meaning is obscured.
- Peer reviewers and editors will translate this to your research.
- Delayed or rejected publication.
Writing Clarifies Thought

- Unclear writing means unclear thinking
- Simply writing ideas down for critical appraisal helps clarify the thought
- Clear writing, then, will clarify:
  - the purpose
  - the conclusions
  - the significance
- Speaking it aloud clarifies the thought
In the elevator, Jane asks William about his recent study on medical curriculum. ”What did you find in your study?”

“Basically, we found that medical teachers of undergraduates tend not to let students look after the difficult patients.”

Later that evening, William sits down at his computer and writes:

“The study confirmed the hypothesis that clinical instructors of undergraduate medical students would choose instructional techniques limiting active student involvement in patient care activities when faced with problematical situations.”
Clear Writing Essentials

- Precision
- Logic
- Directness
- Brevity

Clear Writing
Poor Medical Writing

- Poor Grammar/Punctuation
- Superfluous words, phrases
- Misused words, phrases
- Repetition
- Unnecessary Complexity
- Overuse of passive voice
- Unnecessary Qualification
- Poor flow of ideas
Omit Needless Words, Phrases

- Vigorous writing is concise.

- A sentence should contain no unnecessary words, a paragraph no unnecessary sentences for the same reason that a drawing should have no unnecessary lines and a machine no unnecessary parts.

- This requires not that the writer make all his sentences short or that he avoid all detail and treat his subjects only in outline, but that every word tell.
Needless Modifiers

- Starts out
- Cools off
- Surrounded on all sizes
- Consensus of opinion
- Entirely complete
- Add together
- Absolutely essential
- Skin rash
- Soft in consistency
- Still continues
- Estimated at about

- Audible to the ear
- Tetrahedral in shape
- Small in size
- Red in color
- In close proximity
- Final outcome
- Important essentials
- Adequate enough
- Advance planning
- Fewer in number
- Add together
- Equally as well as
Superfluous Phrases

- It is clear that...
- clearly
- In the event that...
- If
- At the present time
- now, currently
- Due to the fact that
- since
- Subsequent [prior] to
- After (before)
- Due to circumstances that
- because or since
- In a careful manner
- Carefully
- Have an effect (impact) on
- Affect (not impact)
Needless Phrases

- It is interesting to note...
- It should be pointed out...
- It is obvious that...
- Of course... or It is clear that...
- Needless to say...
- Call your attention to the fact...
- This is a subject that...
- In the event that
- In the nature of
- The point I am trying to make..
- It may be argued that...
- In a very real sense
- For the most part
- In the case of
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- This is a subject that...
- In the case of
Wordy Phrases

- in view of the foregoing circumstances
- therefore
- are found to be in agreement
- agree
- has the ability to
- can
- has the capability of
- can
- (with) the passage of time
- (with) time
- at this point in time
- now
- due to the fact that
- because
- examined in comparison to
- compared to
- for the purpose of
- for
- by means of
- by
- a small number of
- few
- a large number of
- many
Word Usage
Word Usage

- Fewer vs less

- Fewer used for number:

  Fewer interventions may mean less care... We evaluated fewer than 100 studies...

- Less used for mass or volume indicating degree or value

  Less than 50 mg of drug was used...
We report 14 cases of diabetes in patients.

In this study, we report on 14 diabetic patients

Subjects (patients) were treated with...

But...

It is too early to judge if this is the case or not...

It is too early to judge if this is so...
Misused Words, Phrases

- **Imply**  Suggest something without stating it
- **Infer**  Draw conclusion from facts, statements

*I imply* that you need to revise your paper; and, *based on my hints, you infer* that I didn’t think highly of your first draft.

- **Effect (noun)**  Result or consequence of something
- **Effect (verb)**  To bring about, accomplish something
- **Affect (verb)**  To change or influence
- **Affect (noun)**  Emotion, feeling (psychology)

*The effect of the corticosteroids on the patient was clearly evident...injection corticosteroids may affect glucose metabolism...Mrs. Jones’s lack of affect was evident...Temperature and pressure affect his limbs*
Misused Words, Phrases

- Do not use *impact* as a verb in place of to affect

  The temperature *impacts* the growth rate of the bacterial sample.
  The temperature *affects* the growth rate of the bacterial sample.

- Do not use *impact* as a noun in place of *effect*

  The release of hydrocarbons has had a significant *impact* on the depth of the ozone layer...
  The release of hydrocarbons has had a significant *effect* on the depth of the ozone layer.
Misused Words, Phrases

- **Because, since**  
  Because preferred—since implies *from the time of (since yesterday)*

- **As**  
  Avoid because it means *while*

- **Continual**  
  repeatedly

- **Continuous**  
  without interruption

For two weeks, the sperm whales *continually dived to great depths in search of food.*

The spectrum of refracted light is *continuous.*
Misused Words, Phrases

- **Abnormal/Normal** Not used for patients or tests per se
- **Negative/Positive** Apply to results, findings

The physical exam was normal
The findings from the exam were normal (or positive, negative)

The throat culture was negative
The throat culture was negative for beta-hemolytic streptococci

The electroencephalogram (or any other test) was positive
The electroencephalogram (test) showed abnormalities in... the temporal lobe
Misused Words, Phrases

- **Compare to vs. Compare with**
  - *Compare to*— to point out similarities between different things
  - *Compare with*— (used more often in science)— to point out differences between similar things

Children with fragile X syndrome are often compared to those with autism because of similarities in behaviors...

Brain tumors are relatively rare compared with more common cancers, such as lung, breast, prostate, and colorectal.
Misused Words, Phrases

- **Prevalence vs. Incidence**

  - **Incidence** is a *rate* = number of NEW cases of a disease occurring in a population within a *specified period of time*, normally 1 year.

  - **Prevalence** refers to the current number of people suffering from an illness in a given year. This includes all those who may have been diagnosed in prior years, and newly diagnosed.

  - The *incidence* of a cancer is 20,000 per year with a *prevalence* of 80,000 *means* 20,000 new cases of cancer are diagnosed every year and there are 80,000 people with this illness, 60,000 of whom were diagnosed in previous years and are still living with the disease.
Misused Words, Phrases

- **Rational** – adjective, meaning *sane or logical*
- **Rationale** – noun, meaning *justification*

The patient appeared to be a *rational* human being.

Their *rationale* for the subject selection was based on age of disease onset.
Parameter, Variable

Parameter is a mathematical term meaning “measurable (numeric) characteristic of a population”

The mean and the standard deviation were the parameters of the distribution...half-life of drug A is a pharmacokinetic parameter...

Parameter does not mean variable or measurement—or limit, boundary, or condition.

Cigarette and alcohol use were the two parameters measured...

It is important that the patient be informed about the parameters of treatment...

...all are without meaning—use variable or better, don’t label them.
Aged not age designates a person’s age. Give precise age when possible.

*The patient, *aged* *70 years, had symptoms of dementia*

* [The 70-year-old patient had...]* Note compound adjective

*The program was designed for children *aged* *5 through 8 years.*

*The teenaged patients with tinnitus… (or better)  The patients with tinnitus, aged 14, 16, and 17 years…*

* It is redundant to add *of age* after the years, since it is implied in the adjectives younger and older
*The patient group comprised women younger than 25 years *[of age].*
Misused Words, Phrases

- **Assure, Ensure, Insure**

- **Assure** means to provide positive information to a person and implies removal of doubt (British: insure)—set the mind at rest.

  > *The technician assured the subjects that their results would be confidential.*

- **Ensure** means to make sure or certain.

  > *The technician ensured that the patient’s test was positive.*

- **Insure** means making precautions beforehand; cover with insurance; guarantee persons against risk.

  > *People should insure their possessions…*
The Sentence
The Sentence

- **Subjects and Verbs**
  - Clarify subject
  - Vigorous verbs
  - Improve subject-verb relationship

- **Parallelism**

- **Placement of Information in Sentence**

- **Brevity and Conciseness**
Write with Clear Subjects, Strong Verbs

- The **physician noticed** the smell of acetone on his breath...

- The smell of acetone on the patient’s breath was something the physician noticed... (Passive)

- Make the topic **your subject** and choose a strong action **verb**:

- **Researchers measured** the atomic mass of the element ...

- **Patient heart rates increased** during the procedure.
Subject-Verb Must Agree

- A review of all patients with grade 3 tumors was undertaken...

- The patient, together with her physician and family, makes the surgery decisions.
A series of fixed duration sequential constant rate infusions... (which adjective is qualifying which noun?)
- Fixed-duration sequential constant-rate infusions
- Sequential infusions of constant rate and fixed duration...

...mouse marrow-derived macrophage colony-stimulating factor (M-CSF) dependent monocytes
- Monocytes, derived from mouse marrow, whose growth was dependent on macrophage-stimulating factor (M-CSF).

Another aspect of spinal fluid biochemical profile complexity.
- Another aspect of the biochemical complexity of spinal fluid.
Passive or Active?

- The active voice is preferred for its greater impact (Active)
  - “We studied the behavior of children...”

- Use the active voice—it has more impact! (Passive)
  - “The behavior of children was studied...”
Passive Voice Breeds Weak Constructions

- In the present study, it was decided to...
- Measurements were taken... It was necessary to...
- In this study, we decided ... We measured ... We had to...

- In the present study, an increase in sugar consumption was observed both in female and male children 1-2 hours after drug A was taken. However, there was no significant sugar consumption increase 3 hours after taking drug A. (39 words)

- [We observed that] girls and boys ate more sugar 1 to 2 hours after taking drug A; within 3 hours, sugar intake decreased (23 words)
Active Voice Breeds Strong Constructions

- The feedthrough was composed of a sapphire optical filter, which was pressed against the pyrotechnic that was used for the confinement of the charge.

- The feedthrough contained a sapphire optical filter, which pressed against the pyrotechnic and confined the charge.
Choose Strong Verbs

- **Strong Verbs:**
  - Prepare, study, think, teach

- **Not weak verbs:**
  - Am, was, been, were, is

- The reason we understood that one-man rule is undesirable *was* our experience with the hospital expansion system.

- The hospital expansion project *taught us* that one-man rule is undesirable.
## Strong vs. Weak Verbs

<table>
<thead>
<tr>
<th>WEAK verb phrases</th>
<th>STRONG verb (active)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Made the arrangement for</td>
<td>Arranged</td>
</tr>
<tr>
<td>Made the decision</td>
<td>Decided</td>
</tr>
<tr>
<td>Performed the development of</td>
<td>Developed</td>
</tr>
<tr>
<td>Made the measurement of</td>
<td>Measured</td>
</tr>
</tbody>
</table>

The human immune system is responsible not only for the identification of foreign molecules, but also for the actions leading to their immobilization, neutralization, and destruction.

The inhibition of the reaction was carried out by…

An increase in heart rate occurred

The human immune system not only identifies foreign molecules, but also immobilizes, neutralizes, and destroys those molecules.

The reaction was inhibited by…

Heart rate increased
The development of memory systems has been of interest...
How memory develops has been of interest...
Our results indicate that the interpretation of this data should be taken with caution.
Our results indicate that data should be interpreted cautiously.
In this patient, the infusion of glucose followed a timed course of every 2 hours
In this patient, glucose was infused every 2 hours.
A new process for eliminating nitrogen oxides from diesel exhaust engines is presented. Flow tube experiments to test this process are discussed. A chemical reaction scheme to account for this process is proposed.

In this paper, we present a new process for eliminating nitrogen oxide from the exhaust of diesel engines. To test this process, we studied this process in flow tubes. To explain the process, we developed (proposed) a scheme of chemical reactions.
When the actor is unknown, unimportant, or receiver of action should be emphasized, use passive.

- The 45-year-old man had been shot in the abdomen and was brought to the emergency department.
- Proponents of this theory are not believed...
- Readers of this work have little esteem for proponents of this theory...

Sometimes the passive is more natural. Particularly, in Methods section, use passive.

- The value of “x” was found to be...
- Subjects were scanned using a novel fMRI method...
- Patients were excluded from the study...
- Measurements of optical refraction were summarized...
Subject-Verb Position

- Information is easier to interpret if you place it where readers expect it to be.

- Readers expect a verb soon after the subject...everything that comes between them gets little attention!
The emergence of virulent Plasmodium falciparum in Africa within the past 6,000 years as a result of a cascade of changes in human behavior and mosquito transmission has recently been hypothesized.
The emergence of virulent *Plasmodium falciparum* in Africa within the past 6,000 years as a result of a cascade of changes in human behavior and mosquito transmission has recently been hypothesized.
According to a recent hypothesis, virulent *Plasmodium falciparum* emerged in Africa within the past 6,000 years as a result of a cascade of (because of cascading) changes in human behavior and mosquito transmission.

- **Subject verb** easy to follow
- Sentence end (stress position) contains the important information.
- **Less important** information does not obscure the message
Paragraphs
Good Paragraphs Use...

- Topic sentences—introduce concept to support ideas.
- Consistent terms throughout.
- Transitions—related one idea to the next.
- Consistent order of terms, ideas.
- Parallel form.
- Logical flow of ideas
- Short form: not long—6 sentences or less. Can be 1.
Use Topic Sentences

- Use a *topic sentence* to announce the paragraph’s topic.

- *Many patients with a chronic wound have other diagnoses that require medical attention.* Frequently encountered are vascular insufficiency, metabolic disturbance... A *treatment plan* for chronic wounds is not adequate until such problems are addressed...

- *Treatment plans are generally divided by physiologic system.* Those dealing with the cardiovascular system...
The incidence and demography of Anorexia nervosa have been extensively characterized (1-21). Anorexia nervosa occurs in roughly 1% of adolescent and young adult females (1-3). Most cases (90%) are female (4-8), and the majority are Caucasian and come from middle-class or higher socioeconomic groups (9-14). Anorexia nervosa is more prevalent in industrialized countries that share a western view that thinness is ideal (15, 16). It develops most frequently during adolescence; mean age of onset is 17 years with bimodal peaks at ages 14 and 18 (17-19). The prevalence of anorexia nervosa has remained constant over the past few decades; one notable change is the higher incidence in women over age 30, although this still represents a minority of cases (20,21).

**Persons with anorexia nervosa frequently manifest symptoms of depression**

Among these symptoms are depressed mood, loss of interest, social withdrawal, insomnia, difficulty in concentrating) and anxiety.

Depression....
Use Consistent Terms

- Drug B has shown to decrease synaptic transmission of serotonin. This reduction in neurotransmitter negative feedback is a result of the drug’s action on presynaptic vesicles in the dendrite.

- Drug B decreases the synaptic transmission of serotonin from presynaptic vesicles from the dendrites of neurons. This decrease in serotonin is produced by drug B’s inhibitory action of K+ ions in the presynaptic vesicles.
This question is discussed in more detail in the following paragraphs.

Thus, many educators believe that if medical students work under difficult conditions during clinical rotations, they will be better prepared for the unpredictable demands of practice.

The unpredictable demands of emergency medicine and critical care...

Because of this, However, Meanwhile, Next, More specifically,

Three hypotheses have been suggested for this. First, ... A second hypothesis... Third,

Use paragraph headings.

Start with a good outline
Transitions: Paragraph Coherence

- Use a clear point carried through, *not* like this:
  - Tetracyclines have been in use since 1948. Their side effects, however, are still a problem. Photosensitivity and tooth discoloration as well as overgrowth of nonsusceptible organisms in the gut must be considered when drugs are prescribed. It has been found that such drugs as gentamycin are useful in eliminating most gram-negative organisms. Tetracyclines are derived from Streptomyces and semisynthetic derivatives...

- Paragraph development: general to specific, important points first, problem (as a question), reasons for argument.
Use Consistent Order

- In describing several ideas or items, keep them in the same order throughout the paper.

- To study the effects of drug A on decreased estrogen production, we measured anterior pituitary leuteinizing hormone, follicle-stimulating hormone, adrenal cortisol, and posterior pituitary oxytocin in premenopausal women. The effect of drug A on oxytocin... Whereas cortisol decreased...

- To study the effects of drug A on decreased estrogen production, we measured anterior pituitary leuteinizing hormone, follicle-stimulating hormone, adrenal cortisol, and posterior pituitary oxytocin in premenopausal women. Leuteinizing hormone decreased in response to drug A, but follicle stimulating hormone...
To determine whether cholinergic or adrenergic nerves mediate release of glucocorticoids from the adrenal gland, we did experiments on glands excised from white rats. To induce release of hormone, we stimulated the tissue both electrically and pharmacologically. To inhibit the hormone, we added an inhibitor to the bathing solution.

To determine whether cholinergic or adrenergic nerves mediate release of glucocorticoids from the adrenal gland, we excised whole adrenal glands from white rats to study them in vitro. We induced secretion of hormone by stimulating the tissue both electrically and pharmacologically. We inhibited secretion of hormone by adding the inhibitor B to the bathing solution.
Using Numbers, Units
Numerals

Use numerals to express numbers unless beginning of a sentence, title/heading, fractions, ordinals (“first”, “second”).

- Six patients of the original 26 patients were...
- Relative risk of exposure was nearly 4 times that of controls...
- Twenty-six samples were collected; only 4 were suitable for study.
- We used 5 mg of ... Five milligrams were used...Fifteen minutes elapsed before... Rats were infused for 15 min...In 2 of the 18 subjects ... Groups 1 and 2 were.... Table 2 lists.... Scores were 2-fold higher... The fourth groups were given 4 mg/kg... The 10th group...
- But There was a half-second delay... In all, three-quarters were...
- There was one problem after another...

Avoid starting a sentence with a large number

- Four hundred thirty-three grams of material were collected (vs We collected 433 g of material... or A total of 433 g...
Numerals

- Use numerals with units of time or measure, and use a space between the number and the unit (except % and °C)
  - 6 min, 125 mg/kg, but 50%, 34°C

- When the number is a decimal, always use a zero to the left of the decimal point.
  - 0.01 (NOT .01)
  - p<0.005

- Spell out the easier of two consecutive numbers
  - In the men over thirty, 16 infections...
  - Of the forty samples, 32 were...
Units of Measure

- Units are not plurals and have no period
- \( L \) not \( Ls, \ sec \ (or \ s) \) not secs, \( g \) not gs, \( cm \) not cms

- Units are collective singular, not plural
- ...100 mg \textit{was} (not \textit{were}) given

- Don’t use ppm, ppb to express concentrations
- Volumes: 2.0 \( \mu L/L \) (not 2 ppm)

- Beginning a sentence
- \textit{Seventy-five milligrams of lidocaine was administered to the patient, and 100 mg was given 20 minutes later.}

- Abbreviations—use with numerals and in tables and figures
- \textit{The dosage was 25 mg/day for four days.}
Units of Measure

- Hyphens join unit and number when used as an adjective
  - An 8-L container...A 10-cm visual analog scale...A 6,000-kg lunar sample
  - Use numbers with units
  - A 4-mL container; 2-m interval (not four ml, two m or four milliliters, sixteen grams)

- Spacing—all given one space except for ° and %
  - 140 nmol/L  40% compliance scale  45° angle  temperature of 7°C

- Decimal format, fractions
  - 0.122 not .122  2.5 kg not 2 1/2 kg
  - One half (or half) of the sample...three-quarters of the patients (not 3/4)

- Don’t put comma between 2 units of same dimension
  - 3 years 4 months old
  - 25 hours 4 minutes
Examples

- A girl 3 months of age presented herself because of a tumor mass protruding from the vulva.
- An infant 3 months old [A 3-month-old infant] was brought to the hospital because of a tumor protruding from the vulva.
- The present studies suggest the possibility that this medication may cause nausea in some cases.
- Our studies suggest that this medication causes nausea in some patients (or) Our studies show this medication may cause nausea in patients.
Examples

- The primary route of lithium elimination from the body is through renal lithium excretion.
- Lithium is eliminated (excreted) from the body primarily through the kidneys.
- In these patients, water consumption increase was observed after drug A was given; the patients on drug B were observed to have no change in water consumption throughout the study.
- Patients who took drug A drank more water [how much?], whereas patients who took drug B drank normally (or had no change in water intake).
To study the mechanisms involved in the beneficial effects of hydralazine on ventricular function in patients who have chronic aortic insufficiency, a radionuclide assessment of ventricular function was performed in 15 patients with pure aortic insufficiency, functional capacity I or II, at rest and during supine exercise. (1 sentence)

We assessed the mechanisms involved in the beneficial effects of hydralazine on ventricular function in patients with chronic insufficiency. For this assessment, we used radionuclides to measure ventricular function in 15 patients at rest and during supine exercise. All patients were diagnosed with pure aortic insufficiency and were rated functional capacity I or II.

(3 sentences with transitions)
The advantages of epidural opiates in the relief of postoperative pain have been repeatedly emphasized. There remains, however, considerable uncertainty as to the consistency and equality of analgesia provided by this technique.

The advantages of epidural opiates for the relief of post-operative pain are well known, although their analgesic consistency and quality are less certain.
In summary, then, foam filled endotracheal cuffs would appear to offer a preferable alternative to low pressure high volume cuffs in terms of protecting the airway and this efficacy is achieved in the context of cuff to tracheal wall pressures that are both predictable and acceptable.

In summary, foam-filled endotracheal cuffs protect the airway better than cuffs with low pressure and high volume. The pressure between the foam-filled cuff and the tracheal wall is predictable and acceptable.
Example

- Baby walkers are devices that provide preambulatory infants with postural support in addition to offering them the opportunity to experience bipedal locomotion. They are intended to simulate the infant’s independent locomotion and by so doing, it is argued, encourage and even accelerate the early acquisition of this skill.

- Baby walkers are devices that allow babies who are still at the crawling stage to stand up and practice walking. Some researchers believe that such devices encourage and even speed up a baby’s ability to walk independently.
Examples

- Recent research suggests that these two disorders may not be as distinct as previously was thought and the degree of overlap may be considerable.

- Recent research suggests that these two disorders may overlap considerably.
The study of Barrett et al. (1997) is considered to be methodologically sound. In that study, 1,000 bacteria were transformed with the novel gene.

In a methodologically sound study by Barret et al. (1997), 1,000 bacteria were transformed with the novel gene.