Scientific Visualisation in the ***AI Era***
Design, Integrity & Publication Success

Dr Udara Senarathne

MBBS, Dip(Com Sys Design), MD(Chem Path)

Chemical Pathologist & Lecturer

Faculty of Medical Sciences, University of Sri Jayewardenepura, Sri Lanka

A/ Lecturer, Department of Medicine, Monash University, VIC, Australia

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A good visual

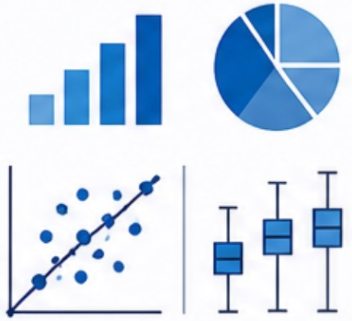
communicates your science

clearly, ethically

& effectively

Learning Objectives

1



Select an appropriate figure or illustration for different types of medical data.

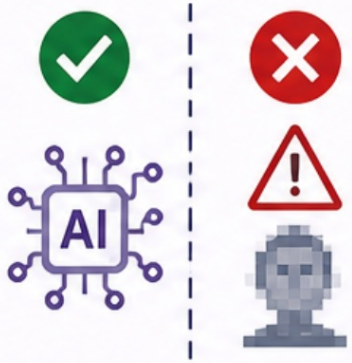
2

Apply fundamental principles of clear and accurate scientific visualisation.

3

Prepare publication-ready figures that meet ethical and technical requirements.

4



Recognise appropriate and inappropriate uses of AI-generated images in medical manuscripts.

5

Perform a basic quality check before submitting figures to a journal.

Why Visuals matter?

human cognition is strongly **adapted** to **visual** information

Why Visuals matter in Scientific Communications?

First impression dictates the REVIEW!

1. First elements examined by editors and reviewers.
2. Communicate complex findings more rapidly than text.
3. Clarifyies the MESSAGE, not a mere decoration!

4. Poor designs obscure valid findings → weaken a manuscript!

3.2 Pompe Disease

Pompe disease (glycogen storage disease type II) is an autosomal recessive lysosomal storage disorder caused by deficiency of acid alpha-1,4-glucosidase (GAA), the lysosomal enzyme responsible for hydrolysing glycogen into glucose. Inadequate enzyme activity leads to progressive accumulation of glycogen within lysosomes, particularly in skeletal and cardiac muscle, resulting in cellular dysfunction and tissue damage.[24]

3.2.1 Molecular and Cellular Pathogenesis

GAA is synthesised in the endoplasmic reticulum as a proenzyme and trafficked via the Golgi apparatus to lysosomes, where it undergoes proteolytic processing to its mature form. Pathogenic variants in the *GAA* gene (17q25.2-q25.3) reduce enzyme activity by affecting protein folding, stability, trafficking or catalytic function.[25] When residual GAA activity falls below a critical threshold (~10–20% of normal), undegraded glycogen accumulates within lysosomes.[26] Lysosomal enlargement and membrane fragility follow, culminating in rupture and release of catabolic hydrolases into the cytosol.[27,28] This triggers autophagic stress, impaired mitochondrial function, oxidative injury and activation of apoptotic pathways.[29] The structural and functional defects are most pronounced in skeletal muscle fibres and cardiac myocytes, explaining the predominant clinical phenotype.

3.2.2 Pathophysiological Consequences

The progressive build-up of glycogen within lysosomes interferes with normal cellular homeostasis (Figure 6). Autophagy is initially upregulated in an attempt to clear damaged organelles, but chronic overload leads to blocked autophagic flux.[30] Swollen lysosomes disrupt calcium handling and membrane dynamics, while secondary activation of inflammatory pathways exacerbates tissue injury.[31] In skeletal muscle, this manifests as myofibre degeneration, weakness and exercise intolerance. In the heart, glycogen deposition impairs contractility and conduction, leading to hypertrophic cardiomyopathy and heart failure.[32,33]

3.2.3 Clinical Spectrum

Pompe disease spans a continuum from the severe infantile-onset form to the more indolent late-onset phenotype.[34] Infantile-onset disease presents within the first months of life with hypotonia, feeding difficulty, macroglossia, cardiomegaly and respiratory failure, typically leading to death within the first year without treatment. Late-onset disease presents from childhood to adulthood with progressive limb-girdle weakness and respiratory insufficiency, with variable cardiac involvement.[35]

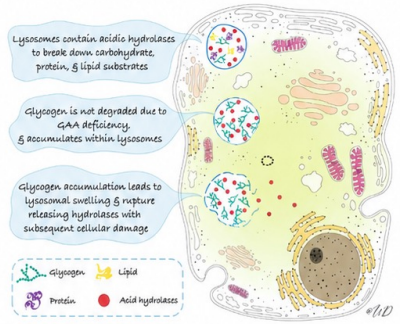


Figure 6 Pathogenesis of Pompe disease due to lysosomal glycogen accumulation (illustration by UDS). GAA, acid alpha-1,4-glucosidase.

3.2.4 Diagnosis

Diagnosis is established by demonstrating markedly reduced GAA activity in dried blood spot, leukocytes or cultured fibroblasts, in conjunction with identification of biallelic pathogenic variants in GAA.[36,37] Biomarkers such as creatine kinase, urinary hexose tetrasaccharide (Hex4) and imaging findings (cardiac MRI, muscle MRI) aid in disease assessment and monitoring.[38,39]

3.2.5 Therapeutic Implications

Enzyme replacement therapy (alglucosidase alfa) remains the cornerstone of treatment, improving survival and motor outcomes, particularly when initiated early.[40,41] Adjunct therapies, including substrate reduction, chaperone therapy and gene therapy, are under investigation.[42,43]

3.2.6 Conclusion

Pompe disease exemplifies how lysosomal enzyme deficiency disrupts cellular homeostasis, leading to multisystem pathology. Advances in early diagnosis and therapeutic strategies continue to improve outcomes, yet challenges remain in treating established organ damage and addressing disease heterogeneity.

References

1. Neufeld EF, Ballabio A. Lysosomal disorders. *Annu Rev Biochem.* 2018;87:645–676.
2. Saftig P, Klumperman J. Lysosome biogenesis and lysosomal membrane proteins: trafficking meets function. *Nat Rev Mol Cell Biol.* 2009;10(9):623–635.
3. Settembre C, Ballabio A. Lysosome: regulators of lipid degradation pathways. *Trends Cell Biol.* 2014;24(12):743–750.
4. Raben N, Puertollano R. Signaling pathways in lysosomal adaptation. *J Cell Sci.* 2016;129(24):4485–4493.
5. Vanier MT. Lysosomal storage diseases. *Handb Clin Neurol.* 2013;113:1713–1744.
6. Kishnani PS, Steiner RD, Bali D, et al. Pompe disease diagnosis and management guideline. *Genet Med.* 2006;8(5):267–288.

Anatomy of FIRST impression

Question to ASK:

Can the main finding of the study be understood from the figure within a few seconds?

Accurate, clear, necessary, self-explanatory

Choosing the right visual format: The Presentation Triad

TEXT

A small number of simple findings.

When to use

When you have one or two key findings that can be stated concisely in words.

EXAMPLE

The mean age of participants was 52 ± 10 years. There was no significant difference in blood pressure between the two groups.

KEY POINT

Use text for clarity and brevity when information is minimal.

TABLE

Precise numerical values and detailed comparisons.

When to use

When exact numbers, multiple variables or detailed comparisons are important.

EXAMPLE

	Group A (n=50)	Group B (n=50)	P value
Age (years), mean ± SD	52.1 ± 10.3	51.7 ± 9.8	0.82
Systolic BP (mmHg), mean ± SD	128.6 ± 15.4	130.2 ± 16.1	0.56
Diabetes, n (%)	12 (24.0)	15 (30.0)	0.48

KEY POINT

Use tables to present precise data clearly and systematically.

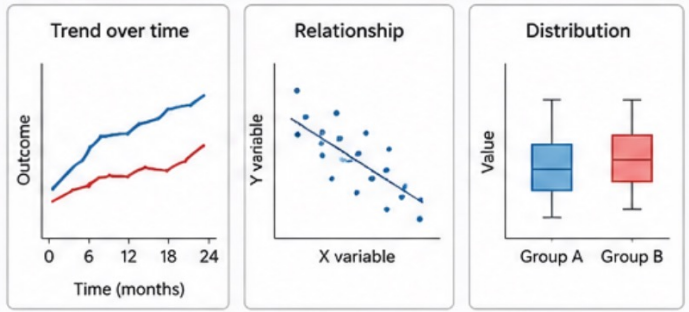
FIGURE

Patterns, relationships, distributions and trends.

When to use

When the goal is to show patterns, trends, relationships or distributions visually.

EXAMPLE



KEY POINT

Use figures to communicate complex information quickly and intuitively.

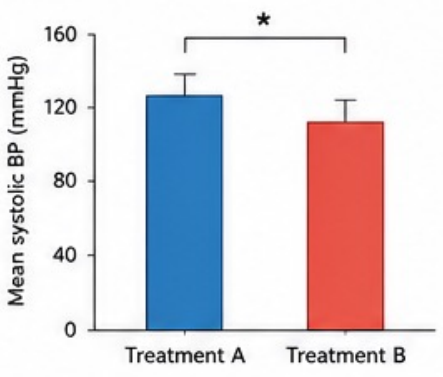
Principles of Effective Figure Design

A ONE FIGURE, ONE MAIN MESSAGE

- Determine the purpose before designing the figure.
- Remove information that does not support the central message.
- Avoid overcrowding multiple unrelated findings into one panel.

GOOD PRACTICE

Focus on one key finding.

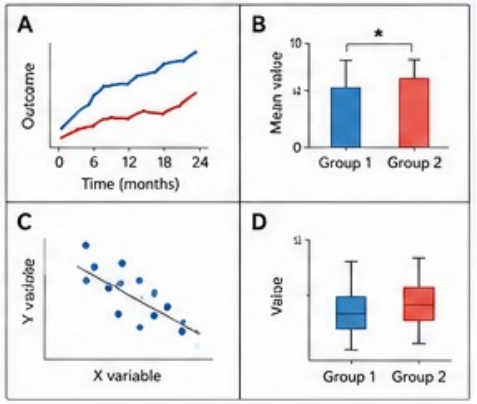


B VISUAL HIERARCHY

- Direct the reader towards the most important comparison.
- Use titles, labels, line thickness and spacing consistently.
- Organise multi-panel figures logically as **A**, **B**, **C** and **D**.

GOOD PRACTICE

Clear title, consistent labels, logical layout.



C AXES AND SCALES

- Label axes clearly and include units.
- Use scientifically appropriate scales.
- Avoid truncated axes that exaggerate differences.
- Use logarithmic scales only when justified and clearly indicated.

GOOD PRACTICE

Label axes clearly and include units. ✓

Start axes at zero. ✓

Use logarithmic scales when justified and label clearly. ✓

Avoid truncated axes. ✗

D FONTS AND READABILITY

- Use consistent, uncomplicated fonts.
- Ensure labels remain readable after reduction to journal column width.
- Avoid excessive decimal places and unnecessary abbreviations.

GOOD PRACTICE

Clear, consistent fonts and appropriate precision.

Parameter	Mean ± SD
Heart rate (bpm)	72 ± 8
Systolic BP (mmHg)	128 ± 15
Glucose (mmol/L)	5.6 ± 0.9

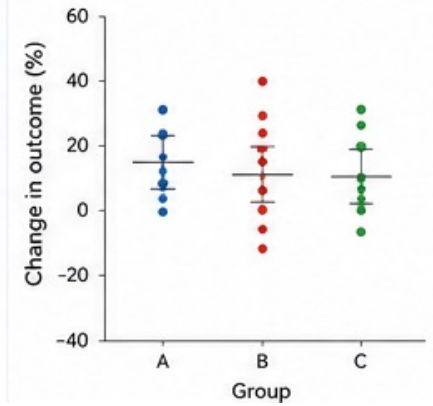
✓ Use appropriate precision and avoid unnecessary abbreviations.

E AVOID VISUAL CLUTTER

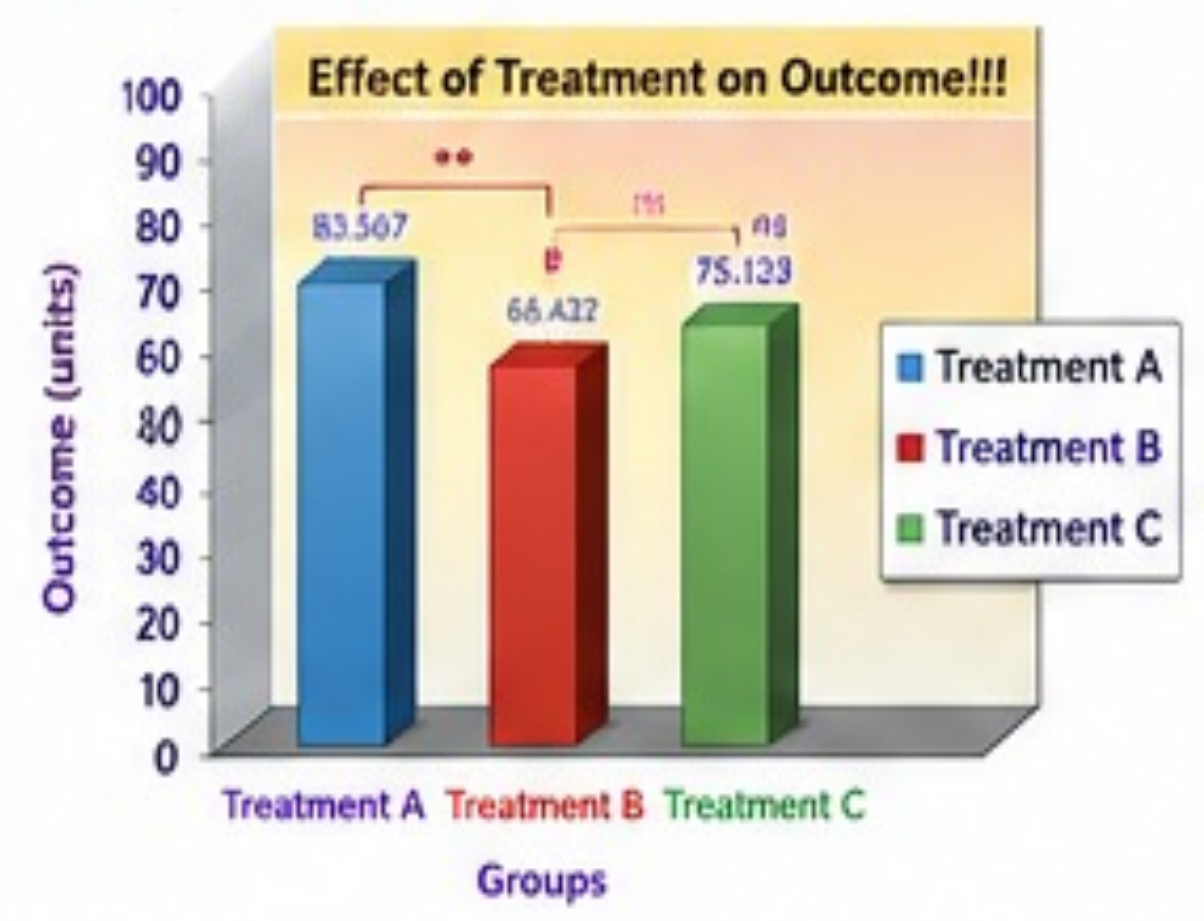
- Remove three-dimensional effects, unnecessary gridlines, shadows and decorative backgrounds.
- Avoid excessive symbols, colours and significance markers.
- Maintain adequate white space.

GOOD PRACTICE

Clean, simple and focused.



Signal over NOISE: Extracting the Message



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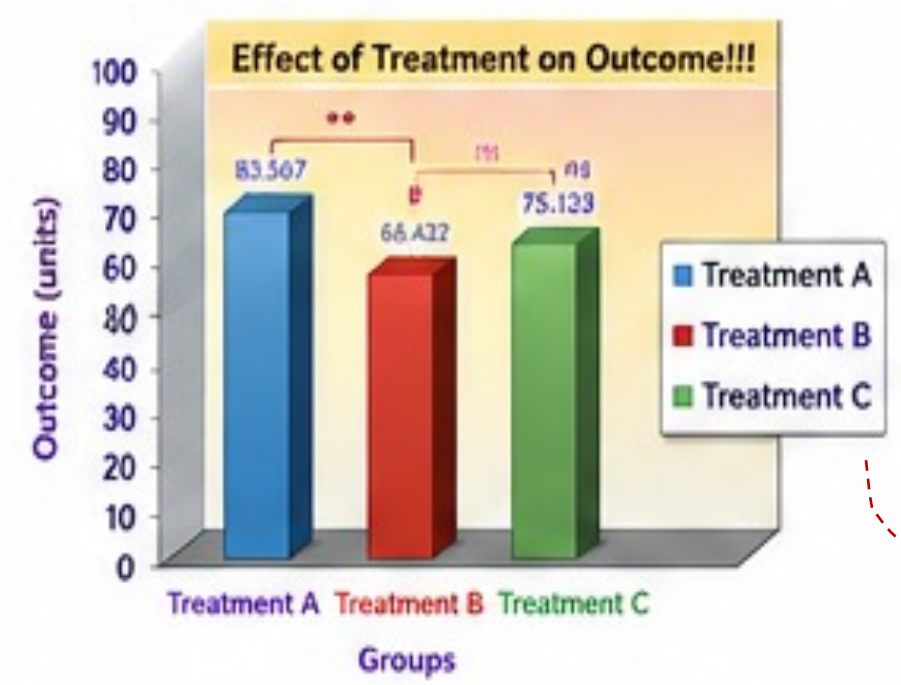
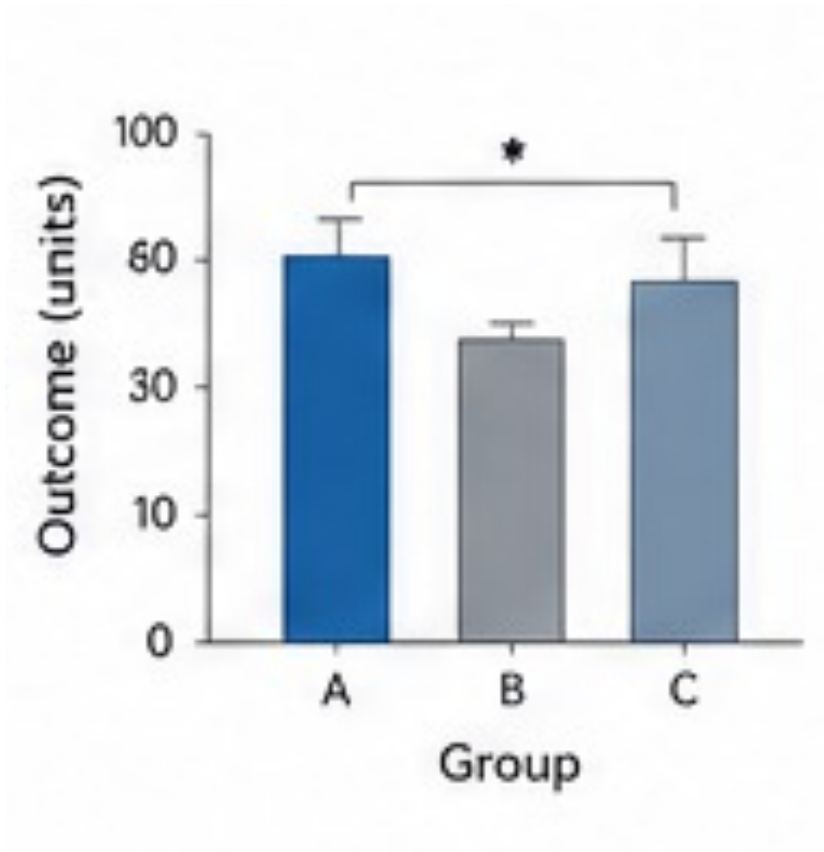




Tips

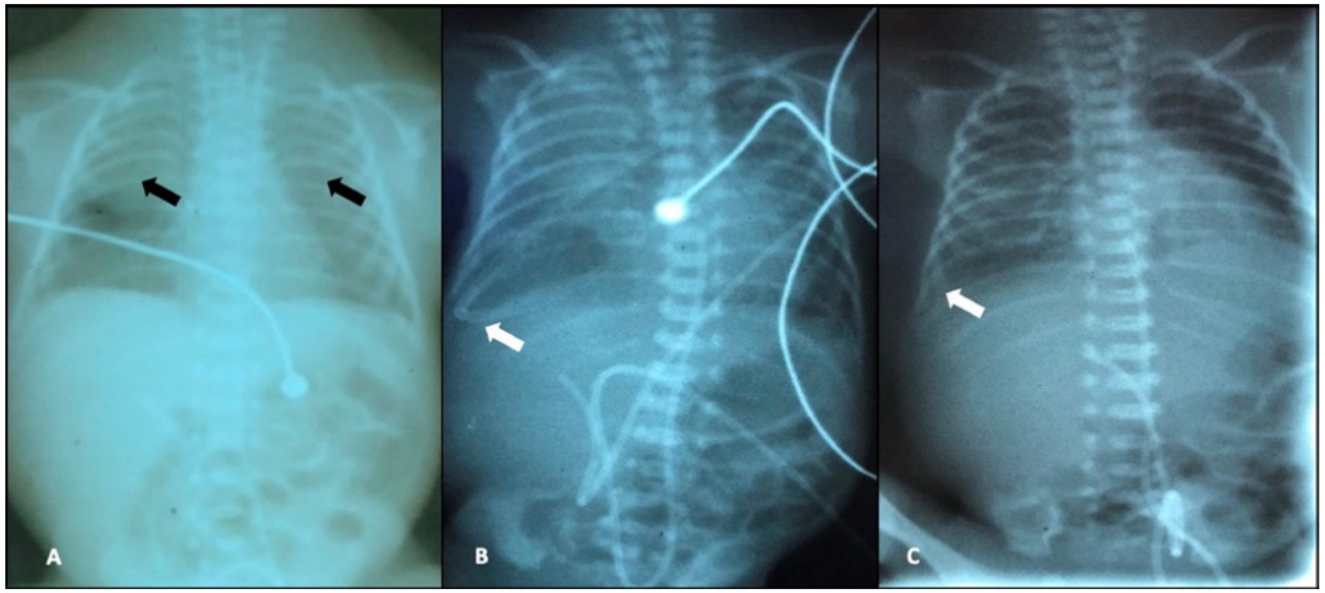


Figure 1 (A) Chest X-ray soon after birth showing ground-glass appearance with air bronchogram on bilateral lung fields. (B) Chest X-ray on day 10 with obliteration of the right-sided costophrenic angle. (C) Chest X-ray following thoracentesis indicating resolution of right-sided pleural effusion.

- Use a logical multi-panel sequence
- Label each panel clearly
- Explain the chronology
- Highlight key findings: Arrows/ circles
- Use a self-contained legend: figure can be understood without referring extensively to the main text.
- Maintain consistent orientation & size
- Crop to the relevant anatomical area
- Protect patient confidentialit
- Use consistent annotations/ Avoid over-annotation

Tips

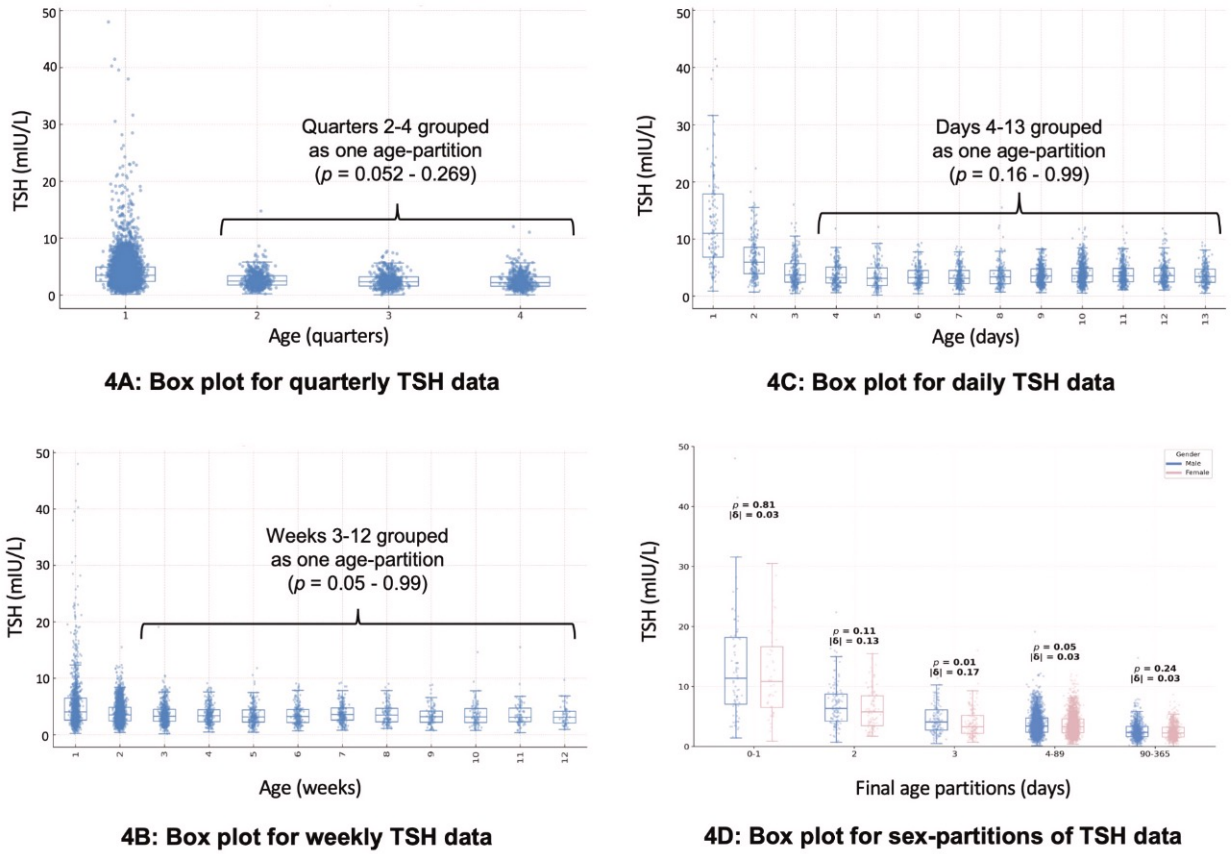


Fig. 4. Boxplots of TSH concentrations analysed by quarterly (A), weekly (B), and daily (C) age groupings, and sex-specific comparisons within the final age partitions (D). Results of the Mann–Whitney U test ($p < 0.05$ considered statistically significant) and effect size estimates using Cliff's delta (negligible effect defined as $|\delta| < 0.15$) are indicated where applicable.

- Keep axis labels and units explicit
- Use consistent scales where comparison is intended
- Show the underlying data
- Match the plot to the data
- Highlight the main analytical conclusion
- Report statistical evidence directly on the figure

Too Many Visuals?

Don’t WORRY!

You have

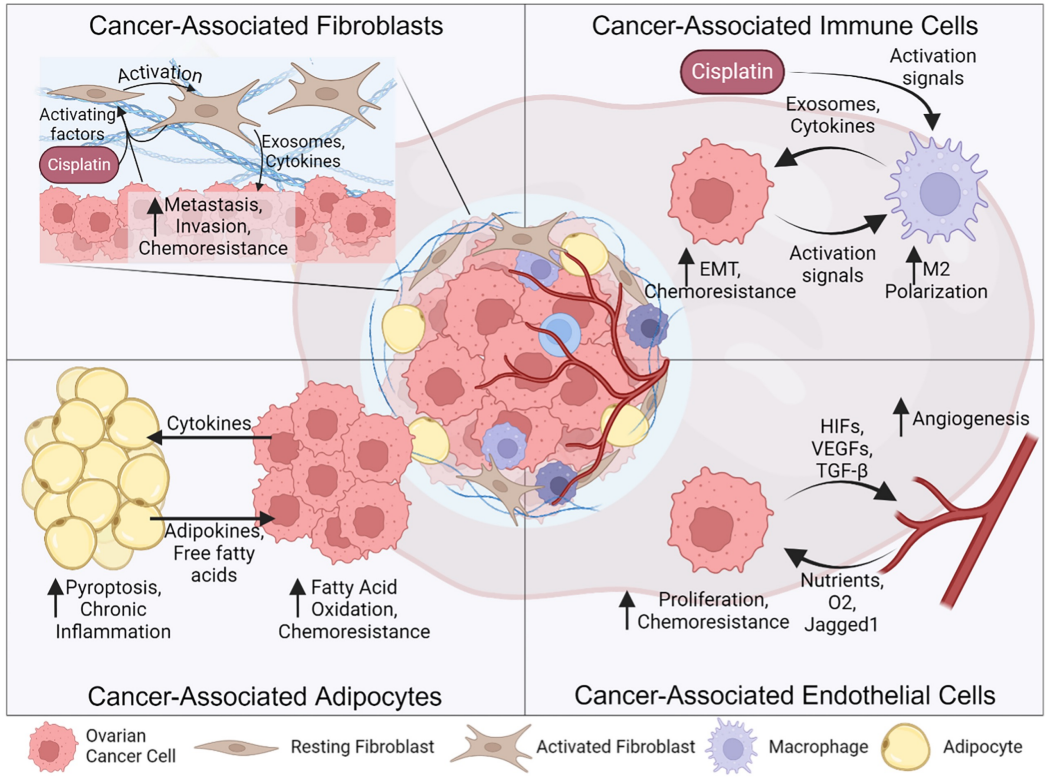
Supplementary Materials

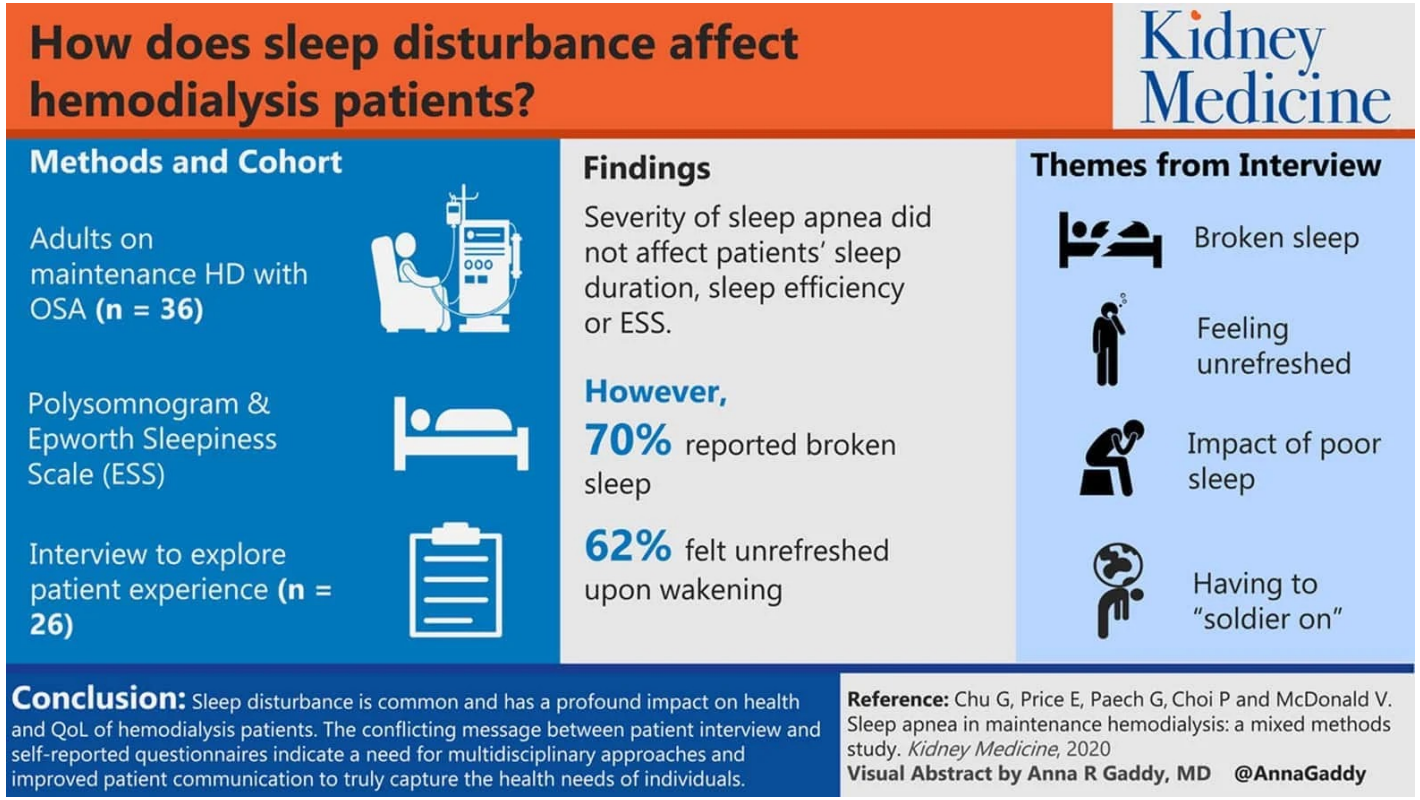
Graphical Abstract

- **Purpose:** Improve visibility, comprehension and dissemination of research.
- **Central message:** Focus on one key finding or take-home message.
- **Visual pathway:** Present a clear flow, such as **Background → Methods → Key result → Implication**.
- **Text–graphic balance:** Use short labels and meaningful visuals rather than dense paragraphs.
- **Simplicity:** Exclude secondary findings, excessive statistics and unnecessary decoration.
- **Digital adaptation:** Ensure readability on journal websites, mobile devices and social media platforms.

Graphical Abstract

Single visual summary of the study's main message





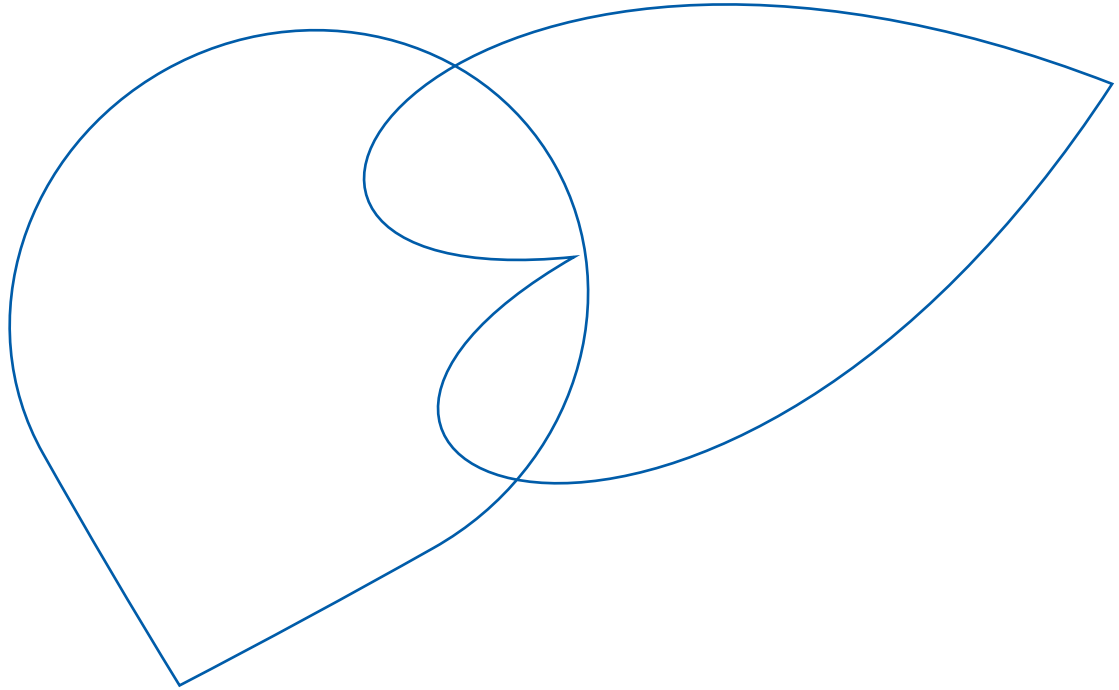
Software & Practical tools

Microsoft Excel and PowerPoint	Data organization, basic analysis, chart creation and slide preparation.
Adobe Illustrator, Inkscape and Affinity Designer	Vector graphics editors for high-quality illustrations, diagrams and layout refinement.
BioRender and similar scientific illustration platforms	Specialized platforms with ready-to-use icons and templates for scientific illustrations.
ImageJ or Fiji for scientific image analysis	Open-source tools for processing and analyzing microscopy and other scientific images.
Reference to reproducible figure-generation workflows	Use documented, reproducible pipelines to ensure transparency and repeatability.
GraphPad Prism	Statistical analysis and publication-ready graphs for biomedical research.
R and ggplot2	Open-source environment for statistical computing and data visualization.
Python and Matplotlib	Programming language and library for data analysis and visualization.

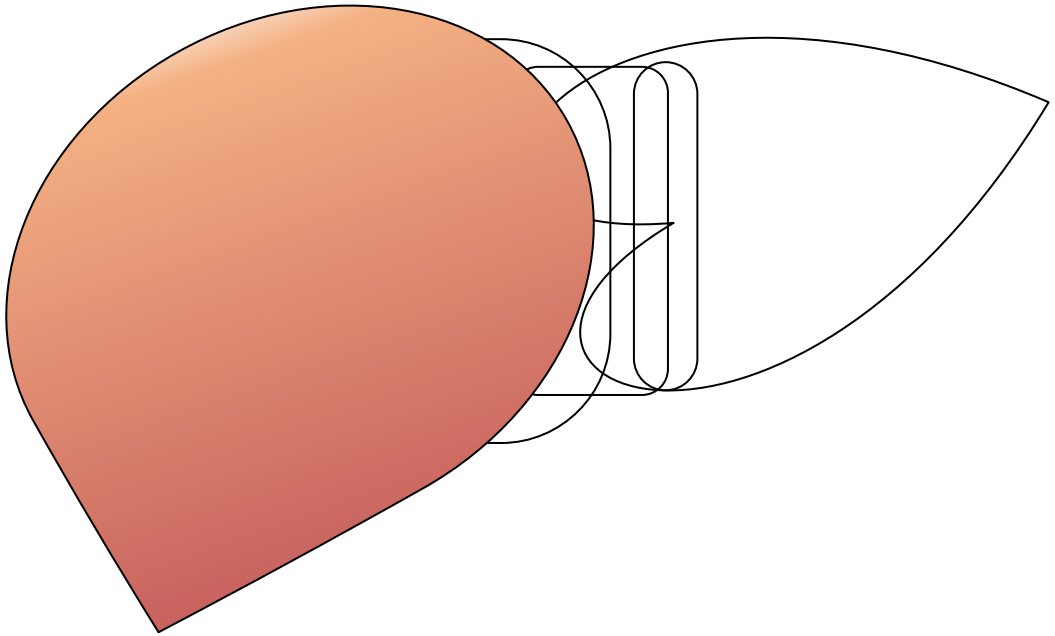
Technical requirements for journal submission

- Raster/Bitmap versus Vector graphics
- Appropriate formats such as TIFF, JPEG, EPS, PDF and SVG
- Resolution requirements:
  - approximately 300 dpi for colour and greyscale images
  - approximately 1,000–1,200 dpi for line art
- Figure dimensions and column widths
- Font embedding and line thickness
- RGB versus CMYK colour modes
  - RGB → electronic publications
  - CMYK → printed publications
- Checking individual journal instructions before submission

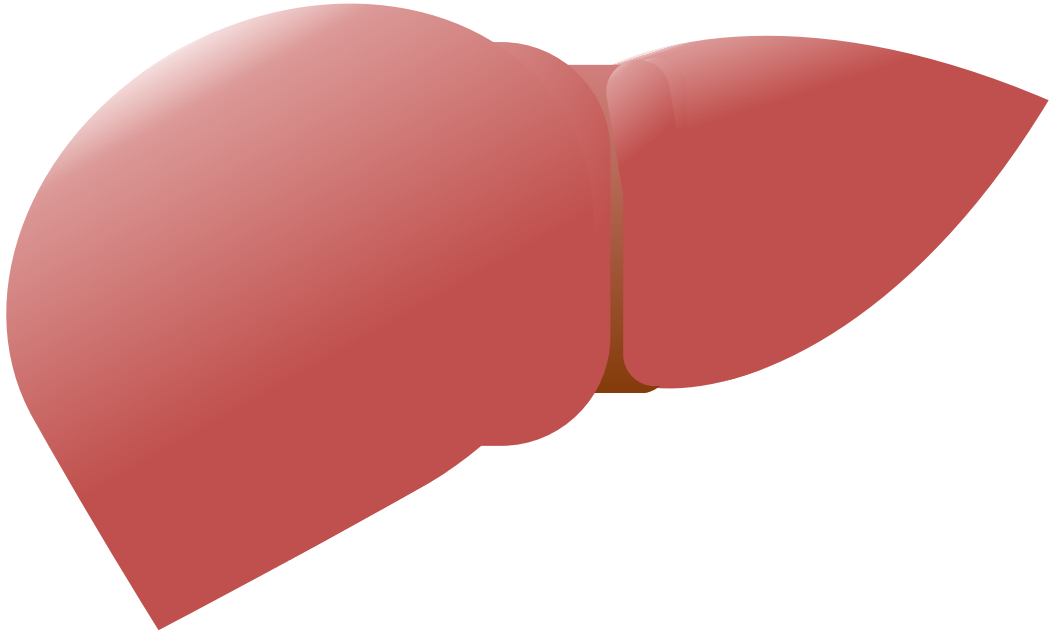
Basic Tools at Hand



Basic Tools at Hand



Basic Tools at Hand



AI-generated images and illustrations

Permitted with disclosure

- **Explanatory images**
  - Flow charts, decision trees, timelines, conceptual schematics and workflow diagrams
  - Must be reviewed for scientific accuracy
  - Disclose the **tool, version and how it was used** in the figure caption and article AI statement

- **Data visualisations**
  - Permitted only when directly and faithfully generated from the underlying dataset
  - Must use reproducible analytical or statistical methods
  - Report the tool, version and developer in the Methods section

AI-generated images and illustrations

Generally not permitted

- **Primary research images**
  - AI must not create, alter or enhance microscopy, histology, radiology, western blots, patient images or other evidential images
  - Routine adjustments should use established image-processing software and remain scientifically faithful

- **Graphical abstracts**
  - Elsevier does not permit general-purpose generative AI image tools for graphical abstracts
  - Dedicated scientific illustration tools with clear licensing are preferred

How to Prompt *Efficiently*?

Create a [type of image] **for** [purpose],
showing [main content], **in a** [style] **style, with** [layout],
using [colour palette],
ensuring [scientific constraints],
in [format/aspect ratio],
&
avoiding [undesired elements].

Hands on Practice

Glycogen molecule

↓ muscle glycogen phosphorylase (cytosol)

Removal of end α-1,4 glycosidic bonds in the glycogen polymer

↓ debranching enzyme

resolves branch points of the glycogen molecule

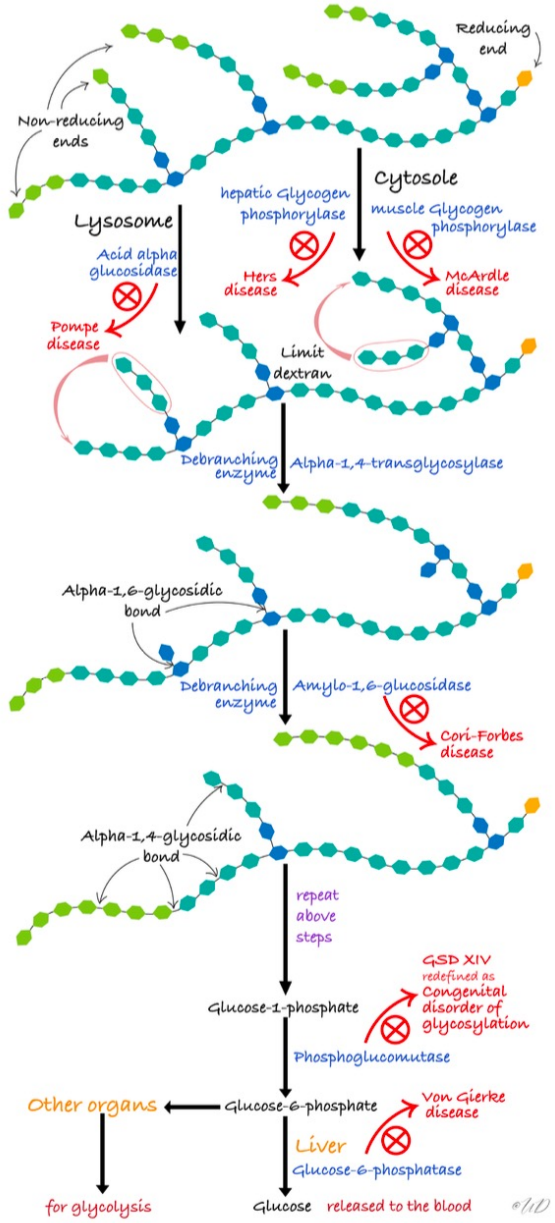


Figure 5 Glycogenolysis pathway with the respective disorders of enzyme deficiency (illustration by UDS). GSD, glycogen storage disease.

Ethical & Publication-integrity

- Image manipulation
- Selective presentation or omission of data
- Reusing previously published figures without crediting
- Copyright and permission requirements
- Proper attribution of adapted figures
- Non-disclosure of software-assisted and AI-generated illustrations
- Fabricated images or unsupported visual reconstructions

Pre-submission quality checklist

- ☐ Does the figure communicate one clear, central message?
- ☐ Is the visual format statistically appropriate for the data?
- ☐ Are axes, units, labels, and sample sizes clearly visible?
- ☐ Are statistical summaries and exact error bars defined?
- ☐ Is the figure perfectly readable at final publication size?
- ☐ Is colour used accessibly (passing the greyscale test)?
- ☐ Are patient confidentiality and genuine image integrity protected?
- ☐ Has AI-assisted content been independently verified and disclosed?
- ☐ Does the file meet target journal resolution and format instructions?
- ☐ Do the figure, legend, main text, and underlying data perfectly agree?

Publication success
depends **not** on making visuals
more **decorative**
but by
making **Scientific Evidence** more
Transparent


Thank
You