Arab Republic of Egypt

Egyptian Pediatric Clinical Practice Guidelines Committee (EPG)
Pediatric Emergency and Critical Care Group

Evidence-Based Clinical Practice Guideline for Pediatric Intravenous Fluid Therapy

Adapted with permission from

AAP: Clinical Practice Guideline: Maintenance Intravenous Fluids in Children (2018)

ESPGHAN/ESPEN: ESPGHAN/ESPEN Guidelines on Pediatric Parenteral Nutrition: Fluids and Electrolytes (2018)

ACCM: American College of Critical Care Medicine guidelines (2017)

SSC: Surviving Sepsis Campaign Guidelines (2020)

NSW: Standards for Pediatric Intravenous Fluids: NSW health (2015)

Starship: Intravenous Fluids and Electrolytes in PICU. Starship child health (2019)

Rch: Intravenous Fluids. The Royal Children's Hospital Melbourne (2020)

First Edition 2022

Disclaimer

Clinical Practice Guidelines (CPGs) are "systematically developed statements to assist health care professionals and patients in medical decision-making for specific clinical conditions" or they are "statements that include recommendations intended to optimize patient care that are informed by a systematic review of evidence and an assessment of the benefits and harms of alternative care options". It is in no way a substitute for a medical professional's independent judgment. Most of the content herein is based on literature reviews. In areas of uncertainty, professional judgment was applied.

This CPG is a working document that reflects the state of the art in the field and is based upon the accessible best-updated published evidence. Because rapid changes in this area are expected, periodic revisions are inevitable. We encourage medical professionals to use this information in conjunction with, and not as a replacement for, their best clinical judgment. The presented recommendations may not be appropriate in all situations. Any decision by practitioners to apply these guidelines must be made considering local resources and individual patient circumstances.

The members of the Egyptian Pediatric Clinical Practice Guidelines Committee (EPG) Guideline Development/ Adaptation Groups (GDG/ GAG) and the external review groups receive no honoraria or expenses to attend the scientific review meetings, nor for the many hours spent reviewing the literature, appraising the guidelines, designing the implementation tools, and contributing to the writing of the report.

Intellectual Property Rights

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Acknowledgements

- The GDG/ GAG acknowledge EPG for its help in completing this project.
- We acknowledge AAP: Clinical Practice Guideline: Maintenance Intravenous Fluids in Children

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  ADDITIONAL SOURCE GLs:

  NSW: Standards for Pediatric Intravenous Fluids: NSW health (2015)

  Starship: Intravenous Fluids and Electrolytes in PICU. Starship child health (2019)

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  (the source original guidelines) for their cooperation in providing permission for adapting our guidelines.
- Finally, we wish the best for all our patients and their families who inspired us. It is for them this work is being finalized.

Funding

- This work is not related to any pharmaceutical or industrial company. The members of the GDG/ GAG and their institutes and universities volunteered their participation and contributions.

Abbreviations

ADH	Antidiuretic hormone
Adolopment	Adoption-Adaptation-Development
AGREE II	Appraisal of Guidelines for Research and Evaluation Instrument
AKI	Acute kidney injury
BP	Blood pressure
BSA	Body surface area
CPG	Clinical Practice Guideline
DHS	Demographic and Health Survey
CNS	Central nervous system
CPGs	Clinical Practice Guidelines
CVP	Central venous pressure
EBM	Evidence based medicine
ECG	Electrocardiography
EPG	Egyptian Pediatrics Clinical Practice Guidelines Committee
EPG CPG	EPG Clinical Practice Guideline
ERG	External Review Group
GAG	Guideline Adaptation Group
GDG	Guideline Development Group
GPS	Good Practice Statement
GRADE	Grading of Recommendations Assessment, Development and Evaluation
HDU	High-dependency unit
HR	Heart rate
IVFs	Intravenous fluids
K	Potassium
MAP	Mean arterial pressure
MV	Mechanical ventilation
NS	Normal saline
PICO	population, intervention, comparison, and outcomes
PICUs	Pediatric intensive care units
PIPOH	Patient population, intervention, professionals, outcomes, and healthcare context
PN	Parenteral nutrition
RCT	Randomized control trial
RIGHT	A Reporting Tool for Practice Guidelines in Health Care
SIADH	Syndrome of inappropriate antidiuretic hormone
TBW	Total body water
US	Ultrasound/ ultrasonographic

Glossary

1. Acceptability
Is the extent to which the users are likely to adopt a recommendation, based on internal qualities such as clarity, comprehensiveness, and logical reasoning and on external factors such as the burden imposed on the process and system of care, patient and providers attitudes and beliefs, and patients needs, expectations, and preferences.

2. Adaptation (of guidelines)
Is the systematic approach to considering the use and/or modification of (a) guidelines(s) produced in one cultural and organizational setting for application in different context? Adaptation can be used as an alternative to de novo guideline development or for customizing (an) existing guideline(s) to suit the local context.

3. Adoption (of a guideline)
Is the acceptance of a guideline as a whole after the assessment of its quality, currency, and content. When health care providers (or other users of recommendations) adopt a guideline, they feel committed to change their practices in accordance with the recommendations of the guideline.

4. Admission
Admission, for the purpose of this guideline, refers to a child being registered and entering inpatient care as a patient. This is distinguished from the term "enrolment", which is used for outpatient care.

5. Applicability
Is the extent to which the users are able to put a recommendation into practice, based on internal qualities such as a clearly defined eligible patient population that matches the population to which the intervention is targeted in the local setting and external factors such as the availability of the necessary knowledge, skills, provider time, staff, equipment, and other resources.
Applicability is sometimes taken as a synonym for feasibility: Feasibility of the acquisition of necessary skills and knowledge Feasibility of the necessary increase in provider time, staff, equipment, and so on.

6. Culture
Culture represents the norms and values of a specific group, community, or population.

7. Diffusion
Is a passive means of transferring knowledge; it is not directed towards a target audience (e.g. publication of articles in medical journals).

8. Dissemination
Is more active than diffusion in that it targets a specific audience and involve tailoring the information for that audience (e.g. of dissemination strategies include targeted mailings, presentations, and press conferences.

9. Evidence-based principles
Evidence-Based Medicine (EBM) has been defined as — the conscientious, explicit, and judicious use of current best evidence in making decisions about the care of individual patients. The practice of EBM means integrating individual clinical expertise with the best available external clinical evidence from systematic research.

10. Evidence tables
Are summaries of the most salient information from studies identified in the systematic review. The elements of evidence tables are dependent on the types of information in studies related to a particular topic but might include information

such as the article reference, the study type (e.g. RCT or Cohort), the number of patients and their characteristics, and the intervention, comparison arms, outcome measures, and effect sizes.

11. Guideline or Clinical Practice Guideline (CPG)
Systematically developed statements about specific health problems, intended to assist practitioners and patients in making decisions about appropriate health care.

12. Guideline consistency
Agreement between the evidence and the recommendations, based on the: Comprehensiveness of the study search and selection process, Coherence between the results of the studies and their interpretation by the guideline authors, and Transparency between interpretation and recommendations.

13. Guideline content
In the 'ADAPTE Manual and Resource Toolkit for Guideline Adaptation' document, guideline content refers to the recommendations in the source guidelines.

14. Guideline currency
A CPG may be considered up to date —when (no) new information on interventions, outcomes, and performance justifies updating (it).

15. Guideline quality
By quality of clinical practice guidelines, we mean the confidence that the potential biases of guideline development addressed adequately and that the recommendations are both internally and externally valid, and are feasible for practice. This process involves taking into account the benefits, harms and costs of the recommendations, as well as the practical issues attached to them. Therefore, the assessment (of quality) includes judgments about the methods used for developing the guidelines, the content of the final recommendations, and the factors linked to their uptake.

16. Guideline topic
In the ADAPTE Manual and Resource Toolkit for Guideline Adaptation' document, the topic refers to the theme of the guideline, as described in the guideline title, for a targeted population (disease and patients) and intervention. The purpose, the audience, and the setting intended for the guideline, although not necessarily explicitly stated in the title, are also part of the topic. A guideline on a given topic may contain more than one health question.

17. Health question or clinical question or key question
Is a precisely described health issue (e.g. clinical, professional practice or public health) relating to the topic of the guideline? Guideline may include one or more questions.

18. Implementation
Implementation includes methods to promote the uptake of research findings into routine healthcare in both clinical and policy contexts and hence to improve the quality and effectiveness of healthcare. It includes the study of influences on healthcare professional and organizational behavior.

19. Intra-class correlations
Intra-class correlations provide a measurement of the extent to which two or more raters agree when rating the same set of things. It is a reliability index and is typically a ratio of the variance of interest over the sum of the variance of interest plus error.

20. Recommendation
Any statement that promote or advocate a particular course of action in clinical care.

21. Stakeholder
A stakeholder is an individual, group and/or organization with a stake in your decision to implement a guideline. Stakeholders include individuals or groups who will be directly or indirectly affected by the implementation of a guideline.

22. Source guideline
In the ADAPTE Manual and Resource Toolkit for Guideline Adaptation' document, source guideline refer to those guidelines selected to undergo assessments of quality, currency, content, consistency, and acceptability/applicability and upon which an adapted guideline may be based.

Executive Summary

Intravenous fluid therapy is an essential component of care for most hospitalized children. It is very common everyday practice in pediatric inpatient, emergency, critical care as well as day care settings. Providing appropriate fluid therapy is integral to patient care. Monitoring, prevention and correction of electrolyte disturbances is also a critical aspect in acutely ill and hospitalized children.
In addition to the general practice of fluid therapy, there are a variety of special situations requiring specific goals and practices regarding fluid therapy. Trauma, burns, perioperative patients and those with metabolic disturbances such as diabetic ketoacidosis, salt-losing adrenal crisis and AKI may require specific fluid protocols.

This guideline focuses on the composition of IVF needed to preserve a child's extracellular volume while simultaneously minimizing the risk of developing volume depletion, fluid overload, or electrolyte disturbances, such as hyponatremia or hypernatremia. The goal is to promote safe and effective fluid therapy for pediatric patients in various settings of care

Guideline development process and methods
After reviewing all the inclusion and exclusion criteria and quality appraisal results, the GDG/ GAG recommended using the following source original clinical practice guidelines (CPGs):
1- AAP: Clinical Practice Guideline: Maintenance Intravenous Fluids in Children (2018)
2- ESPGHAN/ESPEN: ESPGHAN/ESPEN Guidelines on Pediatric Parenteral Nutrition: Fluids and Electrolytes (2018)
3- ACCM: American College of Critical Care Medicine guidelines (2017)
4- SSC: Surviving Sepsis Campaign Guidelines (2020)
5- NSW: Standards for Pediatric Intravenous Fluids: NSW health (2015)
6- Starship: Intravenous Fluids and Electrolytes in PICU. Starship child health (2019)
7- Rch: Intravenous Fluids. The Royal Children's Hospital Melbourne (2020)
We conducted Adolopment for these guidelines: (Adoption, Adaptation, and Development)

- Adoption for most of the guideline recommendations.
- Development of Good Practice Statements

Recommendations and Good Practice Statements (GPS)
This version of the CPG includes recommendations and good practice statements on the following four sub-sections:

A. Providing appropriate fluid therapy to promote safe and effective therapy for pediatric patients in various settings of care
B. Monitoring, prevention and correction of electrolyte disturbance.

We can summarize the guidelines' recommendations for Pediatric Intravenous Fluid Therapy in the following:

- We recommend that normal maintenance fluid requirements in children and infants beyond the neonatal period : (Holliday and Segar formula)
  A. the first 10 kg; 100 /kg/day (4ml/kg/hour)
  B. weight between 10 and 20 kg +50 ml/extra kg/d (+2 ml/extra kg/h)
  C. weight above 20 kg +20 ml/extra kg/d (+1 ml/extra kg/h)
  Sum total requirements A +B+ C. (strong recommendation).

- We suggest that 2/3 of normal maintenance rate should be used in most unwell children unless they are dehydrated. (Weak (conditional) recommendation).

- We suggest that 20-50% increase in maintenance fluids may be required in patients on radiant heaters. (Weak (conditional) recommendation).

- We suggest that bnormal losses should be replaced as well. The losses of the preceding 4 hours should be replaced over the following 4 hours. (Weak (conditional) recommendation).

- We suggest that negative balance (intake below maintenance requirements) is suggested in patients with fluid overload. (Good practice statement).

- We recommend that Isotonic solutions with appropriate potassium and dextrose are preferred in sick pediatric patients requiring maintenance IV fluids especially during the first 24h. (Strong recommendation).

- We suggest that fluids with 0.45% sodium chloride content or balanced electrolyte solutions may be considered alternatives (Weak (conditional) recommendation).

- We recommend that maintenance potassium chloride at 20 mmol/L may be added unless arterial or venous K is greater than 5mmol/L. (Strong recommendation).

- We recommend that final mixture glucose concentration of 5% is recommended when no other source of carbohydrate is provided. (Strong recommendation).

- We suggest that different concentrations of glucose may be used:
  In children older than 6 months with any brain problem, glucose should only be added if required. (Weak (conditional) recommendation).

- We suggest that glucose concentration of 10% is suggested in infants below six months of age. (Weak (conditional) recommendation).

- We suggest that glucose concentration of 10% is required in critically ill patients with acute hepatic failure or suspected in-born errors of metabolism. (Good practice statement)

- We recommend that patients with hypovolemic shock or distributive shock (including septic & anaphylactic shock) should receive fluid resuscitation:
  Amount: 20 mL/Kg per bolus, Type: isotonic crystalloid (eg normal saline) (30)
  Duration: push or rapid infusion over 5-10 min. (Strong recommendation).

- We suggest that patients with cardiogenic shock should only receive fluid resuscitation if they are judged to have preload insufficiency.
  Cardiac ultrasonography evaluation is recommended during such assessment. (Good practice statement).

- We suggest that patients with poor cardiac function may also be volume depleted. Smaller boluses (5-10 mL/kg) should be given more slowly (over 10-20 min) for these patients. (Good practice statement).

- We recommend that fluid resuscitation should be avoided or discontinued when there is evidence of intravascular volume overload.
  During fluid resuscitation, monitor for the development of increased work of breathing, rales, hypoxemia, cardiac gallop rhythm, hepatomegaly or a diminishing MAP-CVP.
  Initial volume resuscitation should be omitted if rales or hepatomegaly are present. (Strong recommendation).

- We recommend that fluid boluses may be repeated with the goal of normal perfusion, cardiac output and blood pressure provided there are no signs of fluid overload.
  A total of up to 60 mL/Kg may be needed during the first hour.
  (Strong recommendation).

- We suggest that patients should be assessed for the presence & severity of dehydration and deficits should be replaced according to the degree of dehydration. (Good practice statement).

- We suggest that replacement should generally be over 24 hours; however:
  - Longer duration is required in cases of diabetic ketoacidosis (48h) or hypernatremia (48-72h)
  - Rapid rehydration over 3-6hrs (min. 6hrs in infants) may be used in cases with gastroenteritis except when rapid fluid administration needs to be avoided (eg heart failure, sodium disturbances). (Good practice statement).

- We suggest that 0.9% saline or a balanced electrolyte solution, with 5% glucose and appropriate potassium, is recommended for replacement of ongoing losses or dehydration. (Weak (conditional) recommendation).

- We suggest that commercially available rehydration solutions with appropriate (20-30mmol/L) potassium may be an alternative. (Good practice statement).

- We suggest that treatment of hyponatremia must be based on the underlying cause. Corrections of severe hyponatremia should be slow, over at least 48-72h. (Weak (conditional) recommendation).

- We suggest that correction of hypernatremia should be addressed using free water replacement. In dehydrated patients, a hypotonic fluid (such as 0.45 saline), with appropriate glucose & potassium, should be given at 1.25-1.5 times normal maintenance. (Good practice statement).

- We recommend that plasma glucose & electrolytes should be checked at the onset of IV fluid therapy and at least daily. (Strong recommendation).

  We recommend that patients receiving IV fluids should be monitored for signs of dehydration, oedema/ overload, daily weight and fluid intake/ output. (Strong recommendation).

Guideline Registration

PREPARE (Practice guideline REgistration for transPAREncy), WHO Collaborating Center for Guideline Implementation and Knowledge Translation, EBM Center, University of Lanzhou, Lanzhou, China. **Registration Number:** ((submitted and in process)). Link: http://www.guidelines-registry.org/

Introduction

Maintenance intravenous fluids (IVFs) are used to provide critical supportive care for children who are acutely ill. IVFs are required if sufficient fluids cannot be provided by using enteral administration for reasons such as gastrointestinal illness, respiratory compromise, neurologic impairment, a perioperative state, or being moribund from an acute or chronic illness. In defining appropriate maintenance IVFs it should include the composition of IVF needed to preserve a child's extracellular volume while simultaneously minimizing the risk of developing volume depletion, fluid overload, or electrolyte disturbances, such as hyponatremia or hypernatremia.

Because maintenance IVFs may have both potential benefits and harms, they should only be administered when clinically indicated. The administration of hypotonic IVF has been the standard in pediatrics. Concerns have been raised that this approach results in a high incidence of hyponatremia and that isotonic IVF could prevent the development of hyponatremia. Guidelines for maintenance IVF therapy in children have primarily been opinion based, and evidence-based consensus guidelines are lacking.**(1)**

The goal of fluid therapy is to preserve the normal body water volume and its electrolyte composition **(2)**

● Maintenance therapy replaces the ongoing daily losses of water and electrolytes occurring via physiologic processes (urine, sweat, respiration, and stool), which normally preserve homeostasis. Maintenance requirements vary depending on the patient's underlying clinical status and setting, especially in postoperative or hospitalized children, due to changes in their physiologic responses (eg, excess antidiuretic hormone [ADH] secretion).

● Repletion therapy corrects water and acute electrolyte deficits that have accrued via illness or physiologic abnormality. Repletion returns the patient to a normal volume and electrolyte status.

Emergency and Critical care provision are aimed at maintaining 'homeostasis' in the body which is vital for the organ's support and optimal function. This involves not only fluids but also electrolytes balance. Electrolyte imbalances are common in pediatric patients.**(3)**

Five possible mechanisms for the occurrence of electrolyte imbalance are:

• Underlying disease process,

• End organ injury,

• Fluid & electrolyte interventions,
• Use of medications with potential electrolyte derangements
• Application of critical care technology i.e. positive pressure ventilation.**(4)**

The higher and lower value of critical electrolytes like sodium, potassium and chloride can affect cellular processes drastically as it may result in cardiac and neurological complications.**(5).**

Delayed correction and prolonged electrolyte imbalances alter the patient`s status in terms of morbidity and mortality. Electrolyte imbalance significantly affects the quality of life of the patient.**(6)** These imbalances also result in longer stay in hospitals thus adding significantly to the costs of management.**(7)** Thus early recognition and intervention to correct these imbalances is essential to avoid poor outcome.**(8)**

Hypernatremia is defined as a serum sodium concentration of more than 145 mEq/L. It is characterized by a deficit of total body water (TBW) relative to total body sodium levels due to either loss of free water; infrequently, the administration of hypertonic sodium solutions .**(9)**

Neurologic complications related to hypernatremia occur in 15% of patients. The neurologic sequelae consist of intellectual deficits, seizure disorders, and spastic plegias. In children with acute hypernatremia, mortality rates are as high as 20 %.**(10)**

Hyponatremia is defined as a plasma sodium concentration of less than 135 mEq/L .**(11)** Acute, severe hyponatremia that develops within 48 hours may develop acute cerebral edema and various sequelae, such as headache, lethargy, seizures, and cardiac arrest due to brain stem herniation.**(12)** Recent evidence suggests that even mild chronic hyponatremia sequelae can be associated with subtle neurologic defects, such as impairments in balance and attention that can increase the incidence of falls.**(13)**

Potassium is the second most abundant cation in the body. About 98% of potassium is intracellular, particularly in skeletal muscle, where the concentration ranges from 140 to 150 mEq/L. Only about 2% of the body's potassium is in the extracellular fluid, where the concentration is tightly regulated at 3.5 to 5.5 mEq/L.**(14)**

Hyperkalemia is defined as a serum potassium concentration of > 5.5 mEq/L, it is moderate (6 to 7 mEq/L) and severe (> 7 mEq/L). Clinical manifestations of hyperkalemia include weakness, confusion, and muscular or respiratory paralysis. Early electrocardiographic (ECG) changes seen with hyperkalemia and may ultimately progress to complete heart block, Ventricular arrhythmias or cardiac arrest may ensue if no effort is made to lower the serum potassium level.**(15)**

Hypokalemia is defined as serum potassium level less than 3.6 mEq/L occurs in up to 21% of hospitalized patients.**(16)** Hypokalemia is often asymptomatic. But some warning signs should be cautiously evaluated which include weakness or palpitations or changes on ECG.**(17)**

Purpose and Scope

These guidelines have been developed to standardize the delivery of services and to implement safe and effective fluid therapy for pediatric patients in various settings of care.

It provides guidance to primary health care providers, pediatricians and specially trained nurses.

This version of the guideline includes recommendations and good practice statements for provision of maintenance fluid therapy, fluid resuscitation and correction of fluid deficits and sodium abnormalities.

Methods

Methods of search:

A comprehensive search for guidelines was undertaken to identify the most relevant guidelines to consider for adaptation.

Keywords used for search are: Pediatric fluid therapy, Intravenous Fluid, shock therapy, maintenance therapy.

Inclusion / exclusion criteria followed in the search and retrieval of guidelines to be adapted:

• Selecting only evidence-based guidelines (guideline must include a report on methodology of development including the systematic literature searches and explicit links between individual recommendations and their supporting evidence)
• Selecting national and/or international guidelines
• Specific range of dates for publication
• Selecting peer-reviewed publications only
• Selecting guidelines written in English language
• Excluding guidelines written by a single author
The following three categories of databases and websites were searched:

1. *CPG databases and libraries (e.g., GIN, ECRI, SIGN, DynaMed, BIGG-REC PAHO)*
2. *Bibliographic databases (e.g., PubMed, Google Scholar)*
3. *Specialized professional societies (related to the pediatric subspecialty)*

All retrieved Guidelines were screened and appraised using AGREE II instrument (www.agreetrust.org) by at least two members. The panel decided a cut-off point or rank the guidelines (any guideline scoring above 60% on the rigor dimension was retained)
After reviewing all the previous criteria the GDG/ GAG recommended using these guidelines:
1- AAP: Clinical Practice Guideline: Maintenance Intravenous Fluids in Children (2018)

2- ESPGHAN/ESPEN: ESPGHAN/ESPEN Guidelines on Pediatric Parenteral Nutrition: Fluids and Electrolytes (2018)

3- ACCM: American College of Critical Care Medicine guidelines (2017)

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- Adoption for most of the guideline recommendations.
- Development of Good Practice Statement

Contributors to the guideline development process:
Guideline Development Group (GDG)/ Guideline Adaptation Group (GAG):
The GDG/ GAG included two subgroups; the clinicians/ healthcare providers subgroup and the guideline methodologists' subgroup.
Clinicians Subgroups
The clinicians' subgroup or clinical panel for this guideline included experts with a range of knowledge, technical skills and diverse perspectives in the field of Pediatric Emergency and Critical Care Group.

The main functions of the clinical panel were adolopment of Pediatric Intravenous Fluid Therapy Guidelines, determining the scope of the guideline and guideline, reviewing the evidence, and formulating evidence-informed recommendations in case of changing strength of recommendations.

Guideline Methodologists Subgroup

There were 7 guideline methodologists with expertise in guidelines development, adaptation, GRADE and translation of evidence into recommendations. Methodologists provided orientation and overview of evidence-informed guideline development processes using the GRADE approach, guideline adaptation using the Adapted ADAPTE, provided AGREE II assessment of the source guidelines in collaboration with the clinicians subgroup, generation of the EtD frameworks whenever applicable.

External Review Group:

The External Review Group for this guideline comprises 4 clinical national experts who have interest and expertise in pediatric emergency & critical care.

They were identified by Egyptian Pediatric Clinical Practice Guidelines Committee (EPG) as people who can provide valuable insights during the guideline development process.

The External Review Group was asked to comment on (peer review) the final guideline to identify any criticism on the content and to comment on clarity and applicability as well as issues relating to implementation, dissemination, ethics, regulations, or monitoring, but not to change the recommendations formulated by the GDG/ GAG. The members of the External Review Group were required to submit declarations of interest before the peer review process.

Guideline Development/ Adaptation Group meetings:

GDG/ GAG meetings were organized virtually (weekly/bimonthly). Due to the extensive scope of the guideline, EPG was responsible for overseeing the adolopment process. the timetable and objectives of each meeting. GDG/ GAG meetings were also attended by members of the methodologists. Working rules for each contributor type were outlined by the chair at the start of each meeting, covering aspects such as vocal rights, voting, and evidence to decision and recommendation formulating processes.

Declarations of interests:

Prospective members of the GDG/ GAG were asked to fill in and sign the standard WHO declaration of interest and confidentiality undertaking forms. All guideline members and methodologists were also asked to fill in and sign the standard WHO declaration-of-interests.

Members of the external review group will be asked to fill in and sign the standard WHO declaration-of-interests form before the peer review process.

Evidence for the guideline:

We used the GRADE system (Grading of Recommendations, Assessment, Development and Evaluation) for assigning the quality of evidence and strength of recommendations that includes the following definitions [18]. Informed by the evidence required for the GRADE Evidence to Decision (EtD) framework(s) was(were) done while considering changing strength of recommendations according to availability of some resources in the recommendations.

Description of the interpretation of the GRADE four levels of certainty of evidence:

Table 1. Classification of the Quality of Evidence

High	We are very confident that the true effect lies close to that of the estimate of the effect.
Moderate	We are moderately confident in the effect estimate; the true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different.

Low	Our confidence in the effect estimate is limited; the true effect may be substantially different from the estimate of the effect.
Very Low	We have very little confidence in the effect estimate; the true effect is likely to be substantially different from the estimate of the effect.

GRADE EtD's contextual factors, criteria and considerations that link to the strength of recommendations:
Criteria and Considerations:

1. Benefits and harms: When a new recommendation is developed, desirable effects (benefits) need to be weighed against undesirable effects (risks/harms), considering any previous recommendation or another alternative. The larger the gap or gradient in favor of the desirable effects over the undesirable effects, the more likely that a strong recommendation will be made.

2. Certainty of the evidence about the effects: The higher the certainty of the scientific evidence base, the more likely that a strong will be made.

3. Values and preferences: If there is no important uncertainty or variability in how much people value the main outcomes, it is likely that a strong recommendation will be made. Uncertainty or variability around these values that could likely lead to different decisions, is more likely to lead to a conditional recommendation.

4. Economic implications: Lower costs (monetary, infrastructure, equipment or human resources) or greater cost-effectiveness are more likely to support a strong recommendation.

5. Equity and human rights: If an intervention will reduce inequities, improve equity or contribute to the realization of human rights, the greater the likelihood of a strong recommendation.

6. Feasibility: The greater the feasibility of an intervention to all stakeholders, the greater the likelihood of a strong recommendation.

7. Acceptability: If a recommendation is widely supported by health workers and program managers and there is widespread acceptance for implementation within the health service, the likelihood of a strong recommendation is greater.

Table 2. Classification of the Strengths of Recommendations

Strong	The desirable effects of an intervention clearly outweigh the undesirable effects (or vice versa), so most patients should receive the recommended course of action.
Conditional	There is uncertainty about the trade-offs. The clinician and patient need to discuss the patient's values and preferences, and the decision should be individualized.

Developing good practice statements:
The GDG/ GAG also developed good practice statements for this guideline, which are actionable messages relevant to the guideline questions. The justification for each good practice statement was carefully considered by the GDG/ GAG

with an emphasis that they are clearly needed. Good practice statements were developed, guided by the following GRADE criteria:
1- Message is really necessary with regard to actual healthcare practice
2- Have large net positive consequence (relevant outcomes and downstream consequences) (GRADE EtD domains)
3- Collecting and summarizing the evidence is a poor use of time and resources
4- Include awell-documented, clear rationale connecting indirect evidence
5- Are clear and actionable statements.
The GDG/ GAG collectively drafted and finalized good practice statements with relevant justifications and remarks to help with their interpretation, with close support and input from the consultant and guideline methodologists.

We have used the Reporting Items for Practice Guidelines in Healthcare (RIGHT) extension for adapted guidelines (RIGHT-Ad@pt Tool) as a reporting checklist for this guideline adaptation process as recommended by the EQUATOR network.

Recommendations

Table 3. Recommendations					
A. **Amount of maintenance Fluids**					
N	**Health questions**	**Source Guideline**	**Recommendations**	**Quality of evidence**	**Strength of Recommendation**
A	**In pediatric patients, what is the appropriate amount of maintenance fluids required?**	ESPGHAN/ ESPEN Starship	A1. Normal maintenance* fluid requirements in children and infants beyond the neonatal period: (Holliday and Segar formula) A. the first 10 kg; 100 /kg/day (4ml/kg/hour) B. weight between 10 and 20 kg +50 ml/extra kg/d (+2 ml/extra kg/h) C. weight above 20 kg +20 ml/extra kg/d (+1 ml/extra kg/h)	**Moderate**	**Strong**

			Sum total requirements A +B+ C**.		
		Rch	A2. 2/3 of normal maintenance rate should be used in most unwell children unless they are dehydrated(***)(****) ***Normal maintenance rates are appropriate for well subjects. Most unwell patients secret excess ADH and need less water to avoid overload & hyponatremia. The following conditions are particularly associated with increased risk of excess ADH secretion and may need further restriction: - Acute CNS conditions: head injuries, CNS infections, tumors - Pulmonary conditions: pneumonia,mbronchiolitis, MV - Trauma & postoperative cases (33).	**Low**	**Weak (conditional)**
		Starship	A3. A 20-50% increase in maintenance fluids may be required in patients on radiant heaters.	**Low**	**Weak (conditional)**
		Starship	A4. Abnormal losses should be replaced as well. The losses of the preceding 4 hours should be replaced	**Low**	**Weak (conditional)**

			over the following 4 hours.(36) A5. A negative balance (intake below maintenance requirements) is suggested in patients with fluid overload.		**Good practice statement**

(*) Normal maintenance requirements are based on the assumptions of normal hydration status, normal urine output and absence of abnormal losses.
(**) Maintenance fluids include fluids given from all sources including both oral/enteral and parenteral routes
(***) Normal maintenance rates are appropriate for well subjects. Most unwell patients secret excess ADH and need less water to avoid overload & hyponatremia. The following conditions are particularly associated with increased risk of excess ADH secretion and may need further restriction:
- Acute CNS conditions: head injuries, CNS infections, tumors
- Pulmonary conditions: pneumonia, bronchiolitis, MV
- Trauma & postoperative cases (33)
(****) In patients with anuria and fluid overload, further fluid restriction may be needed. Maintenance would consist of insensible losses (may be estimated as 300-400 ml/m2/24h) and urine volume (36, Starship).

Table 4. Recommendations					
B. Composition of maintenance fluids					
N	**Health questions**	**Source Guideline**	**Recommendations**	**Quality of evidence**	**Strength of Recommendation**
B	**In Pediatric patients, what is the appropriate composition of maintenance fluids?**	AAP ESPGHAN/ESPEN	B1. Isotonic solutions with appropriate potassium and dextrose are preferred in sick pediatric patients requiring maintenance IV fluids (*)(**); especially during the first 24h(***)	**High**	**Strong**
		NSW	B2. Fluids with 0.45% sodium chloride content or balanced electrolyte solutions may be	**Low**	**Weak (conditional)**

			considered alternatives		
		NSW Starship	B3. Maintenance potassium chloride at 20 mmol/L may be added unless arterial or venous K is greater than 5mmol/L.	**Moderate**	**Strong**
		Rch. Starship	B4. A final mixture glucose concentration of 5% is recommended when no other source of carbohydrate is provided.(***)(****)	**Moderate**	**Strong**
		NSW	B5. Different concentrations of glucose may be used: In children older than 6 months with any brain problem, glucose should only be added if required.	**Low**	**Weak (conditional)**
		Starship NSW	A glucose concentration of 10% is suggested in infants below six months of age.	**Low**	**Weak (conditional)**
			A glucose concentration of 10% is required in Critically ill patients with acute hepatic failure or suspected		**Good practice statement**

			in-born errors of metabolism.		

(*) Maintenance fluids normally provide water, sodium, potassium & glucose.

(**) Although maintenance fluids have been prescribed with 30-40mEq/L sodium, matching recommended daily sodium intake (3mEq/ 100 Cal or 100 mL), such fluids are significantly hypotonic and may not be appropriate for acutely ill children as they increase the incidence of hyponatremia.

Isotonic fluids with sodium content similar to plasma are particularly preferred for patients who are at particularly high risk for hyponatremia (27); such as:

- ANY brain problem (32)

- Postoperative and critically ill (28)

- Congenital or acquired heart disease, liver disease, renal failure or dysfunction, adrenal insufficiency; medication known to impair free-water excretion (27)

(***) This should not delay the initiation of PN if indicated (28). Glucose content of maintenance fluids prevents hypoglycemia & ketosis and may be required to maintain fluid osmolality when sodium content is low. It is neither intended nor sufficient as a source of energy. Nutritional support should be initiated as early as possible.

(****) Glucose concentrations refer to the final concentration in the fluid given.

() These recommendations are for INITIAL fluid prescription. Further fluid therapy should be guided by8measured plasma glucose & electrolytes (36).

Table 5. Recommendations					
C. Fluid resuscitation					
N	**Health questions**	**Source Guideline**	**Recommendations**	**Quality of evidence**	**Strength of Recommendation**
C	**In pediatric patients with shock, when and how should fluid resuscitation be given?**	ACCM (EAACI) (30)	C1. Patients with hypovolemic shock or distributive shock (including septic & anaphylactic shock) should receive fluid resuscitation: Amount: 20 mL/Kg per bolus, Type: isotonic crystalloid (eg normal saline) Duration: push or rapid infusion over 5-10 min	**Moderate**	**Strong**
		ACCM SSC (30)	C2. Patients with cardiogenic shock should only receive fluid resuscitation if		**Good practice statement** (39) (37)

			they are judged to have preload insufficiency. Cardiac ultrasonography evaluation is recommended during such assessment.		
		ACCM	Patients with poor cardiac function may also be volume depleted. Smaller boluses (5-10 mL/kg) should be given more slowly (over 10-20 min) for these patients.		**Good practice statement** **(40)**
		ACCM	C3. Fluid resuscitation should be avoided or discontinued when there is evidence of intravascular volume overload: During fluid resuscitation, monitor for the development of increased work of breathing, rales, hypoxemia, cardiac gallop rhythm, hepatomegaly or a diminishing MAP-CVP Initial volume resuscitation should be omitted if rales or hepatomegaly are present.	**Moderate**	**Strong**

		ACCM SSC (32)	C4. Fluid boluses may be repeated with the goal of normal perfusion, cardiac output and blood pressure provided there are no signs of fluid overload(*) A total of up to 60 mL/Kg may be needed during the first hour.	**Moderate**	**Strong**

(*) Tests for volume responsiveness (e.g. passive leg rasing) can be used to judge the need for repeated fluid boluses.

Table 6. Recommendations					
D. Management of dehydration					
N	**Health questions**	**Source Guideline**	**Recommendations**	**Quality of evidence**	**Strength of Recommendation**
D	**In pediatric patients with dehydration, what is the appropriate fluid management?**	NICE (33)	D1. Patients should be assessed for the presence & severity of dehydration and deficits should be replaced according to the degree of dehydration(*)(**)		**Good practice statement**
			D2. Replacement should generally be over 24 hours; however: - Longer duration is required in cases of diabetic ketoacidosis (48h) or hypernatremia (48-72h) - Rapid rehydration over 3-6hrs (min. 6hrs in infants) may		**Good practice statement**

		NSW	be used in cases with gastroenteritis except when rapid fluid administration needs to be avoided (eg heart failure, sodium disturbances) D3. 0.9% saline or a balanced electrolyte solution, with 5% glucose and appropriate potassium, is recommended for replacement of ongoing losses or dehydration. D4. Commercially available rehydration solutions with appropriate (20-30mmol/L) potassium may be an alternative (***)	**Low**	**Weak (conditional)** **Good practice statement**

(*) Total fluids given should cover maintenance requirements, replacement of deficit in dehydrated patients and replacement of ongoing losses (31,36). A negative overall balance may be needed in those with oedema/ overload or SIADH-hyponatremia.
(**) Water deficit can be calculated from the degree of dehydration (% body weight):
Total Deficit (mL) = weight (Kg) x % dehydration x 10 (31,36).
(***) Oral rehydration should be used when appropriate (41).

Table 7. Recommendations					
E. Hypo/Hyper natremia					
N	**Health questions**	**Source Guideline**	**Recommendations**	**Quality of evidence**	**Strength of Recommendation**
E	**In pediatric patients with hypo/ hyper natremia, what is the fluid**	ESPGHAN	E1. Treatment of hyponatremia must be based on the underlying cause. Corrections of severe	**Low**	**Weak (conditional)**

	management?		hyponatremia should be slow, over at least 48- 72h (*)(**)(***). E2. Correction of hypernatremia should be addressed using free water replacement. In dehydrated patients, a hypotonic fluid (such as 0.45 saline), with appropriate glucose & potassium, should be given at 1.25-1.5 times normal maintenance (****)		**Good practice statement** **(42)**

Hyponatremia is defined as plasma sodium less than 135 mmol/litre. Symptoms are most likely to occur with a plasma sodium of less than 125 mmol/litre, or if the plasma sodium has fallen rapidly, at which time the child may present with signs or symptoms of encephalopathy (26).

(*) The rate of correction should not exceed 0.5 mmol/l/h (36), although slower ra*tes* (8mmol/l/24h) have been recommended (42)

(**) The following symptoms may be associated with acute hyponatremia, or its development during IV fluid therapy: headache, nausea, vomiting, irritability, convulsions, impaired consciousness (lethargy, confusion, disorientation), coma and apnea.

(***) Hypertonic (2.7%) saline is recommended for emergency treatment of acute symptomatic hyponatremia. Fluid restriction alone is NOT recommended. A 2mL/kg bolus over 10-15 may be given and repeated once if symptoms persist. If symptoms remain after both boluses, check the plasma sodium level and consider a third bolus (36)

Hypernatremia is defined as plasma sodium greater than 145 mmol/litre. The risk of adverse events increases with the level of sodium and symptoms are usually more noticeable with sodium of over 160 mmol/litre (26). Plasma sodium up to 150mmol/L does not require specific treatment.

(****) Sodium should not be allowed to fall by more than 0.5mmol/litre/hour (12mmol/L per 24 hours). (36).

Table 8. Recommendations					
F. Monitoring					
N	**Health questions**	**Source Guideline**	**Recommendations**	**Quality of evidence**	**Strength of Recommendation**
F	**In Pediatric patients receiving IV fluids, what is**	RCh ESPGHAN	F1. Plasma glucose & electrolytes should be checked at the onset of IV	**Moderate**	**strong**

	the recommended monitoring?	RCh ESPGHAN	fluid therapy(*) and at least daily(**). F2. Patients receiving IV fluids should be monitored for signs of dehydration, oedema/ overload, daily weight and fluid intake/ output	**moderate**	**strong**

(*) Except routine maintenance before elective surgery; unless needed in view of patient's condition or type of surgery (36)

(**) Glucose & electrolytes must be rechecked within 6h after starting iv fluids in critically ill children, those with large losses or abnormal electrolytes (25). Checking should continue until IV fluids are <50% of normal maintenance (33)(36).

Evidence to recommendations: Considerations

The GDG/ GAG was guided by the results of the AGREE II appraisals of the eligible CPGs and thoroughly reviewed the recommendations of the original source WHO CPGs in consideration of local contextual factors related to the national Egyptian health system like burden of the disease, equity, acceptability, feasibility, and other relevant factors. The GDG decided through an informal consensus process to adopt most recommendation. both ETD and changing strength of recommendation were not done in this guideline).

Also, GDG/ GAG develops group of good practice statements to improve acceptability and feasibility.

Implementation Tools and Considerations

To improve healthcare provision, quality, safety, and patient outcome, evidence-based recommendations must not only be developed, but also disseminated and implemented at national and local levels and integrated into clinical practice.

Dissemination involves educating related healthcare providers to improve their awareness, knowledge and understanding of the guideline's recommendations. It is one part of implementation, which involved translation of evidence-based guidelines into real life practice with improvement of health outcomes for the patients.

Implementation requires an evidence-based strategy involving professional groups and stakeholders and should consider the local cultural and socioeconomic conditions. Cost-effectiveness of implementation programs should be assessed.

Specific steps need to be followed before clinical practice recommendations can be integrated into local clinical practice, particularly in low resource settings.

Steps of implementing Pediatric Intravenous Fluid Therapy strategies into the Egyptian health system:

1. Develop a multidisciplinary working group.
2. Assess the status of nutritional care delivery, care gaps and current needs.
3. Select the material to be implemented, agree on the main goals, identify the key recommendations for diagnosis, treatment and prevention and adapt them to the local context or environment.
4. Identify barriers to, and facilitators of implementation.
5. Select an implementation framework and its component strategies.

6. Develop a step-by-step implementation plan:
    - Select the target populations and evaluate the outcome.
    - Identify the local resources to support the implementation.
    - Set timelines.
    - Distribute the tasks to the members.
    - Evaluate the outcomes.
7. Continuously review the progress and results to determine if the strategy requires modification.

Guideline implementation strategies will focus on the following: -

1. **For Practitioners**
    - Educational meetings: conferences, lectures, workshops, grand rounds, seminars, and symposia.
    - Educational materials: printed or electronic information (software).
    - Web-based education: computer-based educational activities.
    - A trained person meets with providers in their practice setting to provide information with the intention of changing the provider's practice. The information may include feedback on the performance of the provider(s).
    - Reminders: the provision of information verbally, on papers or on a computer screen to prompt a health professional to recall information or to perform or avoid a particular action related to patient care.
    - Optimize professional-patient interactions, through mass media campaigns, reminders, and education materials.
    - Practice tools: tools designed to facilitate behavioral/practice changes, e.g., flow charts.
2. **For Patients and care givers**
    - Patient education materials (Arabic booklet): Printed/electronic information aimed at the patient/consumer, family, caregivers, etc.
    - Reminders: the provision of information verbally, on papers or electronically to remind a patient/consumer to perform a particular health-related behaviors.
    - Mass media campaigns.
3. **For Nurses**
    - Educational meetings: lectures, workshops or traineeships, seminars, and symposia.
    - Educational materials: printed.
    - A trained person meets with nurses in their practice setting to provide information with the intention of changing the provider's practice.
    - Reminders: the provision of information verbally, on paper or on a computer screen to prompt them to recall information or to perform or avoid a particular action related to patient care.
    - Practice tools: tools designed to facilitate behavioral/practice changes.
4. **For Stakeholders**

    Plans have been made to contact with all the health sectors in Egypt including all sectors of the Ministry of Health and Population, National Nutrition Institute, University Hospitals, Ministry of Interior, Ministry of Defense, Non-Governmental Organizations, Private sector, and all Health Care Facilities.
    - Information and communication technology: Electronic decision support, order sets, care maps, electronic health records, office-based personal digital assistants, etc.
    - Any summary of clinical provision of health care over a specified period may include recommendations for clinical action. The information is obtained from medical records, databases, or observations by patients. Summary may be targeted at the individual practitioner or the organization.
    - Administrative policies and procedures.
    - Formularies: Drug safety programs, electronic medication administration records.

5. **Other activities to assist the implementation of the adapted guideline's recommendations include:**
   - **International initiative:** Dissemination of the presented adapted CPG internationally via sending the final adapted CPG to the Guidelines International Network (GIN) Adaptation Working Group and contacting the CPG developers.
   - **Gantt chart** has been designed to manage the dissemination and implementation stages for the adapted CPG over an accurate time frame (Appendix).

Evidence to Decision Tables: (if any)

Guideline Implementation Tools

Educational materials based on this Adapted CPG for Pediatric Intravenous Fluid Therapy have been made available in several forms including:
1. Manual for physician for diagnosis and algorithm for Pediatric Intravenous Fluid Therapy
2. Arabic Educational materials for nurses and mothers

Table 3: Normal maintenance fluids by weight

Weight (Kg)	BSA (m^2)	24h maintenance (mL) [a][b]		Maintenance rate (ml/h) [a][c][d]	
3	0.2	300	300	13	13
4	0.24	370	400	15	17
5	0.28	430	500	18	21
6	0.32	480	600	20	25
7	0.36	540	700	23	29
8	0.4	600	800	25	33
9	0.43	650	900	27	38
10	0.47	710	1000	29	42
12	0.54	810	1100	34	46
14	0.61	910	1200	38	50
16	0.67	1000	1300	42	54
18	0.73	1100	1400	46	58
20	0.79	1200	1500	49	63
25	0.93	1400	1600	58	67
30	1.06	1600	1700	66	71
35	1.18	1800	1800	74	75
40	1.28	1900	1900	80	79
45	1.39	2100	2000	87	83
50	1.48	2200	2100	92	88
60	1.65	2400	2300	100	96
70[e]	1.79	2400	2400	100	100

*** Not considering weight losses due to dehydration, extra weight associated with obesity or oedema**
(a) based on Holliday and Segar formula (the right hand column) and 1500mL/m2 BSA (the left hand column)
(b) values up to 1000mL/24h are rounded to 10mL increments and values >1000mL/24 to 100mL increments
(c) all rates are rounded to whole numbers (mL/h)
(d) all rates express TOTAL NORMAL MAINTENANCE. Deductions based on a restricted regimen or fluid contents of

feeds, medications, etc. have NOT been considered

(e) based on adult requirement of 100mL/h

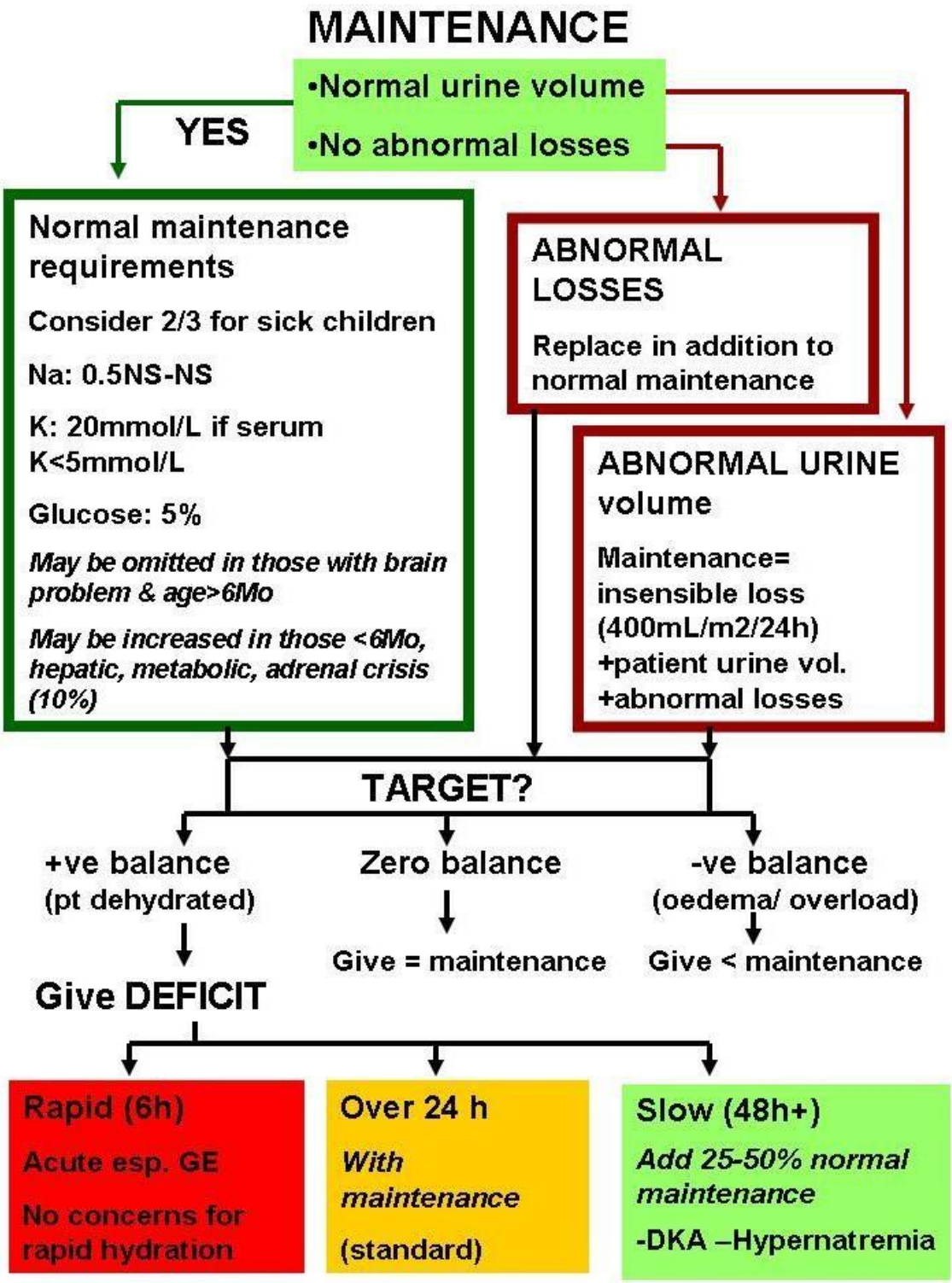

Figure 1: Maintenance & deficit plans chart

Table 4: Types of fluids & mixtures by sodium content (34)

	Na (mEq/L)	Examples	Glucose & K content
Isotonic	±150	Normal saline Ringer & lactated Ringer (Na slightly less)	None K (4-5 mEq/L) in ringer & LR
3/4 NS	±110	Glucose: saline 1:3	1/4th source glucose (2.5% if using 10%), No K
	80-90	IV rehydration premixed solutions	Glucose <5% K varies by brand (8-30mEq/L)
½ NS	77	Glucose: saline 1:1 Half normal saline	½ source glucose (5% if using 10%, 2.5% if 5%), No K
1/3 NS	±50	 Glucose: saline 2:1 Glucose: ½ NS 1:2 1:19 bicarb: glucose (25mL/500) 1:16 bicarb: glucose (30mL/500)	No K. Using 5%, final glucose: 3.3% (6.7% with 10%) 1.7% 5% 5% & higher Na (60mEq/L)
0.2NS	±30	Glucose 10%: saline 4:1 Glucose 10%: 25%: saline 3:1:1 Commercial maintenance solutions	8%, No K 11%, No K 10-12%, K 10-20mEq/L
___	0	Glucose (all conc.)	

Glucose 25% can be used to increase final mixture glucose concentration.
To increase K by 20 mEq/L add 5mL KCl per 500 mL, or 1 mL/100mL

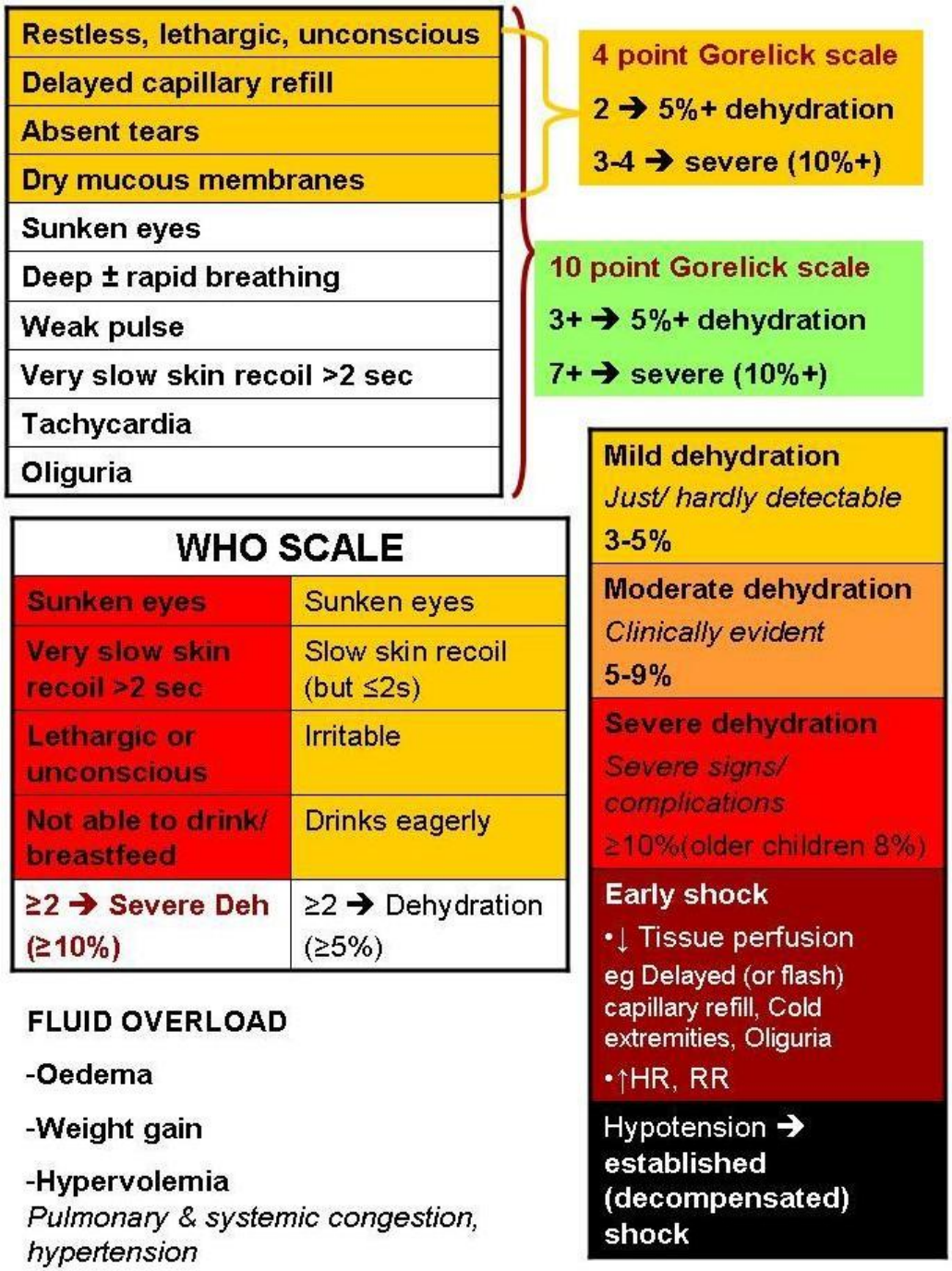

Figure 2: Shock, dehydration & overload assessment chart

Signs of dehydration, shock and overload are shown.

Assessment of dehydration using 4- and 10- point Gorelick scales and WHO scale are presented (35).

Table 5: Fluid balance sheet

Time	Oral/ enteral	Trans-fusion	Medication	IV1	IV2	TOTAL IN	Urine	Out1	Out2	UF	TOTAL OUT	BALANCE
0800												
0900												
1000												
1100												
1200												
1300												
8am--2pm												
1400												
1500												
1600												
1700												
1800												
1900												
2pm-8pm												
Total 8am-8pm												
2000												
2100												
2200												
2300												
0000												
0100												
0200												
0300												
0400												
0500												
0600												
0700												
8pm-8am												
24h total												
											INSENSIBLE	
											Total day	

Figure 3: Hyponatremia & hypernatremia

correction (34) HYPONATREMIA

ECF volume	Pathophysiology	Examples	Management strategy
Reduced (hyponatremic dehydration)	Na loss > water loss	GE, diuretics, adrenal insufficiency, salt-losing nephropathies, etc	**Rehydrate with higher Na** Crude: use NS or 3/4NS & modify according to rate of Na rise Accurate: add 10-12 ml/kg hypertonic saline to total daily fluids
Normal	Free water gain	SIADH	**Water restriction (50-70%)** Use 0.5NS - NS (unless Na restriction is also needed)
Increased	Water> salt retention	Congestive HF, hepatic failure, nephrotic syndrome	

-NS, 3/4NS & ½ NS refer to Na content. Appropriate glucose & K should be added
-Correction rate at no more than 0.5 mEq/Kg hourly, preferably even slower (8/day). Check & modify rate of rise after 6h.
-Severe symptomatic cases: initial partial correction with hypertonic saline, followed by more gradual correction

HYPERNATREMIA

ECF volume	Pathophysiology	Examples	Management strategy
Reduced (hypernatremic dehydration)	Water loss> Na loss	GE	**Give maintenance + 40mL/Kg/day with 1/3NS- ½ NS** **Modify according to rate of Na drop:** - If too slow: ↑rate or ↓Na content, & vice versa
Normal	Free water loss	DI	**Give 40mL/Kg free water (eg G5%) per 24h and the remaining fluids as usual**
Increased	Hypertonic Na intake	Concentrated formula, sea water, Na bicarbonate, etc	

-½ NS & 1/3NS refer to Na content. Appropriate glucose & K should be added.
-Correction rate at no more than 0.5 mEq/Kg hourly (12/day). Check & modify rate of drop after 6h.
-An accurate calculation is possible, based on urine vol, urine Na, insensible loss & current ECF volume status to determine 24h maintenance water & Na requirements separately. Then, allocate 40 mL/kg of the total volume as free water and give the remainder with the proportional amount of calculated Na.
-PD is needed for refractory hyperNa, intractable acidosis or associated AKI with need for dialysis

Limitations and suggestions for further research needs

Future research recommendations for Pediatric Intravenous Fluid Therapy in the Egyptian context could include:

- Frequency of IV fluid using.
- Recommendations for inpatient IV fluids administration & frequent complications.

These recommendations aim to address specific challenges and characteristics of the Egyptian context, potentially leading to more effective Intravenous Fluid Therapy in children.

Challenges

- Awareness of importance of IV fluid correct indications & calculation.

Strengthen the evidence base of the next update of this guideline by generating GRADE summary of finding tables, evidence profiles, and EtD frameworks.

Monitoring and evaluating the impact of the guideline.

The following are three performance measures or indicators for implementing this adapted CPG for Pediatric Intravenous Fluid Therapy:

1. **Adherence to Pediatric Intravenous Fluid Therapy Guidelines**
   - *Numerator:* Number of children with dehydration who received treatment as per guideline recommendations.
   - *Denominator:* Total number of children diagnosed with dehydration.
   - *Data Source:* Hospital or clinic patient records.
2. **Duration of Hospital Stay**
   - *Numerator:* Total number of hospital stay days for children with dehydration.
   - *Denominator:* Total number of children admitted with dehydration.
   - *Data Source:* Hospital admission and discharge records.
3. **Rate of Readmission**
   - *Numerator:* Number of children readmitted with symptoms of dehydration within a certain period (e.g., 30 days) after discharge.
   - *Denominator:* Total number of children initially admitted with dehydration.
   - *Data Source:* Hospital readmission records.

These key performance indicators are designed to measure the effectiveness and adherence to the guidelines, the efficiency of the treatment in terms of resource utilization (hospital stay), and the success of the treatment in preventing further complications (readmissions).

Updating of the guideline

The EPG Pediatric Emergency and Critical Care GAG has decided to conduct the next review of this adapted CPG for updates after five years. This should be carried out in 2029 after checking for updates in the source CPGs, consultation of expert opinion on the changes needed for updating according to the newest evidence and recommendations published in this area and the clinical audit and feedback from implementation efforts in the aforementioned local

healthcare settings except if any breakthrough evidence- based recommendations are published before that date. The process will be guided by the Checklist for the Reporting of Updated Guidelines (CheckUp) Tool that is freely provided by the AGREE Enterprise and by the Reporting Items for Practice Guidelines in Healthcare (RIGHT) extension for adapted guidelines RIGHT-Ad@pt Checklist.

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Annexes

Annex Table 1.
Declaration of Conflict of Interests

The members of the guideline development/ adaptation group and the external review group have no academic, financial, or competing interests to declare and none of them were involved in the development of the original source guideline(s).
Any identified potential COI has been reported below.

Egyptian Pediatric Clinical Practice Guidelines Committee (EPG) *Guideline Adaptation Group (Clinical subgroup)*			
Name	**Affiliation, Area of expertise / Role, Country / Primary location [work]**	**Declaration of interests**	
		Interest identified	**Management plan & decision**
Hanaa Ibrahim Rady	Professor of Pediatrics and Pediatric Intensive Care, kasr Alainy, Cairo University	None	Not Applicable
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Dalia A. Abdelrahman	Professor of pediatric critical care medicine, Zagazig university	None	Not Applicable
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Hafez Bazaraa	Professor of Pediatrics Head of Pediatric Critical Care Unit, Cairo University	None	Not Applicable
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Mervat Gamal Eldin Mansour	Professor of Pediatrics and Pediatric Critical Care, Ain Shams university	None	Not Applicable
Azza Ahmed Eltayeb	Professor of pediatrics and Pediatric intensive care, Assiut University	None	Not Applicable

Effat Hussein Assar	Assistant professor of pediatrics. Head of PICU, Benha university hospital	None	Not Applicable
Sondos mohamed magdy	Associate professor of pediatrics and PICU, Ain shams university	None	Not Applicable
Khaled Talaat	Professor of Pediatrics Head of Pediatric Critical Care Unit Tanta University	None	Not Applicable
Baher Matta Hanna	Professor of Pediatrics & Pediatric Cardiology Cairo University & AFCM	None	Not Applicable
Ahmed rezk ahmed	Associate professor of pediatrics and PICU Ain shams university	None	Not Applicable
Mohamed Mahmood Ahmed Romih	professor of pediatrics and PICU, Zagazig university (ZU)	None	Not Applicable
Sally Ahmed Farid El-Sahrigy	professor of Pediatrics and Pediatric Cardiology Former Head Of Pediatrics Department Medical Research and Clinical Studies Institute National Research Center NRC	None	Not Applicable
Hanaa Abdel Rady	Associate professor of pediatrics and PICU ain shams university	None	Not Applicable
Noha Al-Anwar	Associate professor of pediatrics and PICU ain shams university	None	Not Applicable
Tarek Abdel Lateef	Associate professor of pediatrics and PICU ain shams university	None	Not Applicable
Guideline Adaptation Group (Methodology Subgroup)			
Prof. Ashraf Abdel Baky	Professor of Pediatrics Ain Shams University, Egypt Founder and Chair of EPG	None	Not Applicable
Dr. Yasser Sami Amer	1. Pediatrics Department and Clinical Practice Guidelines and Quality Research Unit, Quality Management Department, King Saud University Medical City, Riyadh, Saudi Arabia; 2. Research Chair for Evidence-Based Health Care and Knowledge Translation, King Saud University, Riyadh, Saudi Arabia; 3. Chair, Adaptation Working Group, Guidelines International Network (GIN), Perth, Scotland	None	Not Applicable

	4. Department of Internal Medicine, Ribeirão Preto Medical School, University of São Paulo (FMRP-USP), Ribeirão Preto, São Paulo, Brazil.		
Dr. Lamis Mohsen Elsholkamy	Lecturer of Pediatrics, Faculty of Medicine, Modern University for Technology and Information (MTI), Egypt	None	Not Applicable
External Review Group			
Prof. Mohamed Attia Bayoumi	Professor of Pediatrics and Pediatric Critical Care Faculty of Medicine, Mansoura University	None	Not Applicable
Prof. Nabil Abd-El Aziz	Professor of Pediatrics Former head of the Pediatric Gastroenterology division Former head of Mounira Children Hospital PICU Cairo University	None	Not Applicable
Prof. Soheir Ibrahim	Professor of Pediatrics Faculty of Medicine, Al Azhar University	None	Not Applicable
Prof. Tarek Abd El Gawwad	Professor of Pediatrics Former head of PICU Ain Shams University		
External Reviewer for methodology			
Prof. Iván D. Flórez	Department of Pediatrics, University of Antioquia, Medellín, Colombia, Department of Health Research Methods, Evidence, and Impact, McMaster University, Hamilton, Canada, Leader, AGREE Collaboration (Appraisal of Guidelines for Research & Evaluation) Director, Cochrane Colombia	None	Not Applicable
Prof. Airton Tetelbom Stein	Professor Titular de Saúde Coletiva, Fundação Universidade Federal de Ciências da Saúde de Porto Alegre (UFCSPA), Porto Alegre, Brazil	None	Not Applicable

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Web annexes

The following annexes can be added as a package of standalone supplementary documents.

Keywords: The MeSH terms for "Guideline for Pediatric Intravenous Fluid Therapy in the Egyptian context" on PubMed are: Pediatric fluid therapy, Intravenous Fluid, shock therapy, maintenance therapy.

Appendix Table 4. The RIGHT-Ad@pt checklist

7 sections, 27 topics, and 34 items		Assessment	Page(s)*	Note(s)
BASIC INFORMATION				
Title/subtitle				
1	Identify the report as an adaptation of practice guideline(s), that is include "guideline adaptation", "adapting", "adapted guideline/recommendation(s)", or similar terminology in the title/subtitle.	☒ Yes ☐ No ☐ Unclear		
2	Describe the topic/focus/scope of the adapted guideline.	☒ Yes ☐ No ☐ Unclear		
Cover/first page				
3	Report the respective dates of publication and the literature search of the adapted guideline.	☒ Yes ☐ No ☐ Unclear		
4	Describe the developer and country/region of the adapted guideline.	☒ Yes ☐ No ☐ Unclear		
Executive summary/abstract				
5	Provide a summary of the recommendations contained in the adapted guideline.	☒ Yes ☐ No ☐ Unclear		
Abbreviations and acronyms				
6	Define key terms and provide a list of abbreviations and acronyms (if applicable).	☒ Yes ☐ No ☐ Unclear		
Contact information of the guideline adaptation group				
7	Report the contact information of the developer of the adapted guideline.	☒ Yes ☐ No ☐ Unclear		
SCOPE				
Source guideline(s)				
8	Report the name and year of publication of the source guideline(s), provide the citation(s), and whether source authors were contacted.	☒ Yes ☐ No ☐ Unclear		
Brief description of the health problem(s)				
9	Provide the basic epidemiological information about the problem (including the associated burden), health systems relevant issues, and note any relevant differences compared to the source guideline(s).	☒ Yes ☐ No ☐ Unclear		
Aim(s) and specific objectives				
10	Describe the aim(s) of the adapted guideline and specific objectives, and note any relevant differences compared to the source guideline(s).	☒ Yes ☐ No ☐ Unclear		
Target population(s)				
11	Describe the target population(s) and subgroup(s) (if applicable) to which the recommendation(s) is addressed in the adapted guideline, and note any relevant differences compared to the source guideline(s).	☒ Yes ☐ No ☐ Unclear		
End-users and settings				
12	Describe the intended target users of the adapted guideline, and note any relevant differences compared to the source guideline(s).	☒ Yes ☐ No ☐ Unclear		
13	Describe the setting(s) for which the adapted guideline is intended, and note any relevant differences compared to the source guideline(s).	☒ Yes ☐ No ☐ Unclear		

Appendix Table 4. The RIGHT-Ad@pt checklist

7 sections, 27 topics, and 34 items		Assessment	Page(s)*	Note(s)
RIGOR OF DEVELOPMENT				
Guideline adaptation group				
14	List all contributors to the guideline adaptation process and describe their selection process and responsibilities.	☒ Yes ☐ No ☐ Unclear		
Adaptation framework/methodology				
15	Report which framework or methodology was used in the guideline adaptation process.	☒ Yes ☐ No ☐ Unclear		
Source guideline(s)				
16	Describe how the specific source guideline(s) was(were) selected.	☒ Yes ☐ No ☐ Unclear		
Key questions				
17	State the key questions of the adapted guideline using a structured format, such as PICO (population, intervention, comparator, and outcome), or another format as appropriate.	☒ Yes ☐ No ☐ Unclear		
18	Describe how the key questions were developed/modified, and/or prioritized.	☐ Yes ☒ No ☐ Unclear		
Source recommendation(s)				
19	Describe how the recommendation(s) from the source guideline(s) was(were) assessed with respect to the evidence considered for the different criteria, the judgements and considerations made by the original panel.	☐ Yes ☒ No ☐ Unclear		
Evidence synthesis				
20	Indicate whether the adapted recommendation(s) is/are based on existing evidence from the source guideline(s), and/or additional evidence.	☐ Yes ☒ No ☐ Unclear		
21	If new research evidence was used, describe how it was identified and assessed.	☐ Yes ☒ No ☐ Unclear	NA	
Assessment of the certainty of the body of evidence and strength of recommendation				
22	Describe the approach used to assess the certainty/quality of the body/ies of evidence and the strength of recommendations in the adapted guideline and note any differences (if applicable) compared to the source guideline(s).	☐ Yes ☒ No ☐ Unclear	NA	
Decision-making processes				
23	Describe the processes used by the guideline adaptation group to make decisions, particularly the formulation of recommendations.	☒ Yes ☐ No ☐ Unclear		
RECOMMENDATIONS				
Recommendations				
24	Report recommendations and indicate whether they were adapted, adopted, or *de novo*.	☒ Yes ☐ No ☐ Unclear		
25	Indicate the direction and strength of the recommendations and the certainty/quality of the supporting evidence and note any differences compared to the source recommendations(s) (if applicable).	☒ Yes ☐ No ☐ Unclear		
26	Present separate recommendations for important subgroups if the evidence suggests important differences in factors influencing recommendations and note any differences compared to the source recommendations(s) (If applicable).	☒ Yes ☐ No ☐ Unclear		
Rationale/explanation for recommendations				
27	Describe the criteria/factors that were considered to formulate the recommendations or note any relevant differences compared to the source guideline(s) (if applicable).	☒ Yes ☐ No		

Appendix Table 4. The RIGHT-Ad@pt checklist

7 sections, 27 topics, and 34 items		Assessment	Page(s)*	Note(s)
		☐ Unclear		
EXTERNAL REVIEW AND QUALITY ASSURANCE				
External review				
28	Indicate whether the adapted guideline underwent an independent external review. If yes, describe the process.	☒ Yes ☐ No ☐ Unclear		
Organizational approval				
29	Indicate whether the adapted guideline obtained organizational approval. If yes, describe the process.	☒ Yes ☐ No ☐ Unclear	SNS & NEBMC	
FUNDING, DECLARATION, AND MANAGEMENT OF INTEREST				
Funding source(s) and funder role(s)				
30	Report all sources of funding for the adapted guideline and source guideline(s), and the role of the funders.	☒ Yes ☐ No ☐ Unclear		
Declaration and management of interests				
31	Report all conflicts of interest of the adapted and the source guideline(s) panels, and how they were evaluated and managed.	☒ Yes ☐ No ☐ Unclear		
OTHER INFORMATION				
Implementation				
32	Describe the potential barriers and strategies for implementing the recommendations (if applicable).	☒ Yes ☐ No ☐ Unclear		
Update				
33	Briefly describe the strategy for updating the adapted guideline (if applicable).	☒ Yes ☐ No ☐ Unclear		
Limitations and suggestions for further research				
34	Describe the challenges of the adaptation process, the limitations of the evidence, and provide suggestions for future research.	☐ Yes ☒ No ☐ Unclear	--	