Electrolyte and mineral water quality in intensive therapeutic feeding centres: informing standards development

SCIENTIFIC DAYS

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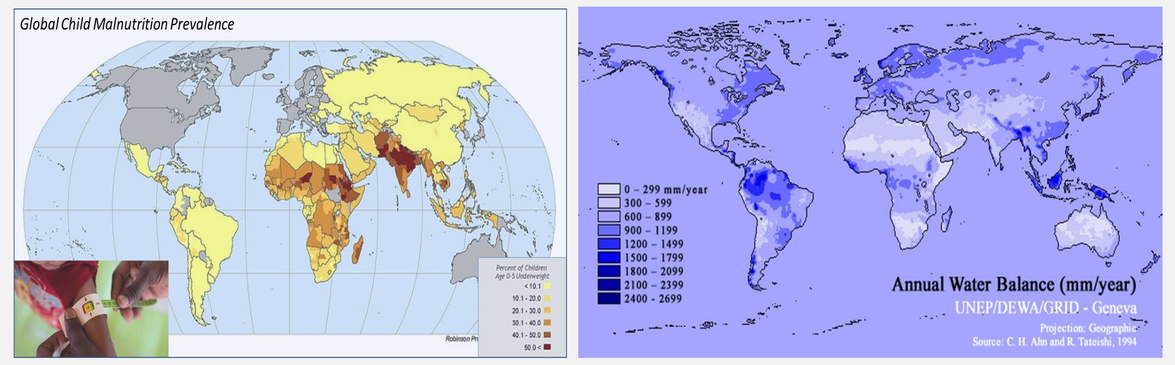
Severe acute malnourished (SAM) patients are extremely sensitive to electrolyte and mineral levels, and high concentrations might influence treatment outcomes – water quality guidance is urgently needed.

BACKGROUND and PROJECT AIM

An unusual mortality cluster was observed in an ITFC during the 2017 nutritional crisis in **Somali region of Ethiopia,** reigniting a discussion about the health impact of mineral (chemical) water quality (WQ) on SAM patients. **Highly mineralised groundwater might have impacted treatment outcomes in this and other MSF interventions** (e.g. Somalia 2007). This project has the objective of synthesising knowledge around this topic and contributing to the establishment of concrete guidelines for MSF field teams.



Mapping of global malnutrition (http://sedac.ciesin.columbia.edu/data/set/povmap-global-subnational-prevalence-child-malnutrition/maps and a global map of annual water balance (right) – UNDEP.

Many geographic areas with a high prevalence of malnutrition (above left) are reliant on groundwater which is likely to be highly mineralised due to a low water balance – evaporation is high and rainfall low (see above right). Other hydrogeological factors, such as geology and sea water intrusion, can also adversely impact water quality. MSF field teams need better guidance on water quality testing and new options for water treatment to face these challenges.

THE METHOD

① Identify those water quality parameters of most concern in ITFCs using a **toxicological risk assessment approach**:

② **Convene an expert panel** to generate provisional recommendations and identify knowledge gaps. Nutritionists, water and sanitation specialists, clinicians and regulatory toxicologists were represented and took part in a 2 day workshop held at York University.

③ **Carry out a systematic literature review** to gather available data on the upper limits of intake for the parameters of concern for the population of interest using the PRISMA approach and considering the **P**opulation, **I**ntervention, **C**omparison and **O**utcomes (PICO).

RISK ASSESSMENT

24 water quality parameters were identified as possible hazards. An **exposure assessment tool** was developed to quantify the total minerals of reconstituted treatment products (ORS, Resomal, F100 and F75) used under various treatment regimens (see below). A worst case WQ scenario was applied to this calculation tool to compare with standard upper limits from various regulatory bodies, e.g. USEPA and US Institute of Medicine.

Four parameters were considered to be most significant: **sodium, magnesium, sulphate and nitrate/nitrite**. Only nitrate/nitrite have health based WQ guidance, the others have guideline values based on acceptability alone. Other WQ parameters (e.g. fluoride and arsenic) were considered to be issues over periods of more chronic exposure rather than at the acute level SAM patients are subject to.

		TOTAL PATIENT DAILY EXPOSURES (incl. Breastmilk)								ULs to Apply
		Phase 1	Phase 1 + Plan A	Phase 1 + Plan B	Phase 1 + Plan C	Phase 2	Phase 2 + Plan A	Phase 2 + Plan B	Phase 2 + Plan C	Updated: 4-Oct
ACWQ Parameter	Unit	unit/day	unit/day	unit/day	unit/day	unit/day	unit/day	unit/day	unit/day	Age Range: 7-12mo
										Dim.: unit/day
Calcium	mg	543.33	556.38	665.13	734.73	766.14	779.19	887.94	957.54	1500
Magnesium	mg	87.47	95.70	164.29	208.19	205.02	213.25	281.85	325.75	65
Sodium	mg	204.72	263.56	753.89	1067.70	530.12	588.96	1079.29	1393.10	1500
Potassium	mg	727.92	799.56	1396.53	1778.59	1548.05	1619.68	2216.65	2598.72	ND
Sulphate	mg	373.03	423.63	845.32	1115.20	750.86	801.46	1223.15	1493.02	400
Chloride	mg	619.53	648.74	892.11	1047.87	929.93	959.14	1202.51	1358.27	2300
Bicarbonate	mg	191.64	217.77	435.54	574.91	386.76	412.89	630.66	770.03	n/a
Carbonate	mg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	n/a
Nitrate	mg	240.48	273.27	546.55	721.44	485.33	518.13	791.40	966.30	4.8
Nitrite	mg	0.08	0.09	0.18	0.24	0.16	0.17	0.26	0.32	0.48
Fluoride	mg	1.69	1.92	3.83	5.06	3.40	3.63	5.54	6.77	0.9
Boron	mg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.6
Barium	mg	0.01	0.01	0.02	0.03	0.02	0.02	0.03	0.04	0.6
Iron	mg	0.40	0.40	0.40	0.41	3.57	3.57	3.57	3.57	40
Manganese	mg	2.34	2.34	2.35	2.35	2.35	2.35	2.35	2.35	0.42
Aluminum	mg	0.01	0.01	0.02	0.02	0.01	0.01	0.02	0.03	0.04
Chlorine	mg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.3
Chloramine	mg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.3
Arsenic	mg	0.00036	0.00041	0.00083	0.00109	0.00073	0.00078	0.00119	0.00146	0.0009
Chromium	mg	0.00396	0.00450	0.00900	0.01188	0.00799	0.00853	0.01303	0.01591	0.009
Copper	mg	136.50	136.63	137.70	138.39	138.30	138.43	139.50	140.19	1000
Lead	mg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.012
Molybdenum	mg	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.015
Selenium	µg	27.57	27.57	27.57	27.58	41.27	41.27	41.28	41.28	60
Zinc	mg	11.15	12.03	19.38	24.09	15.51	16.39	23.75	28.46	5
Water	L	0.55	0.60	0.97	1.21	0.90	0.95	1.32	1.56	0.8

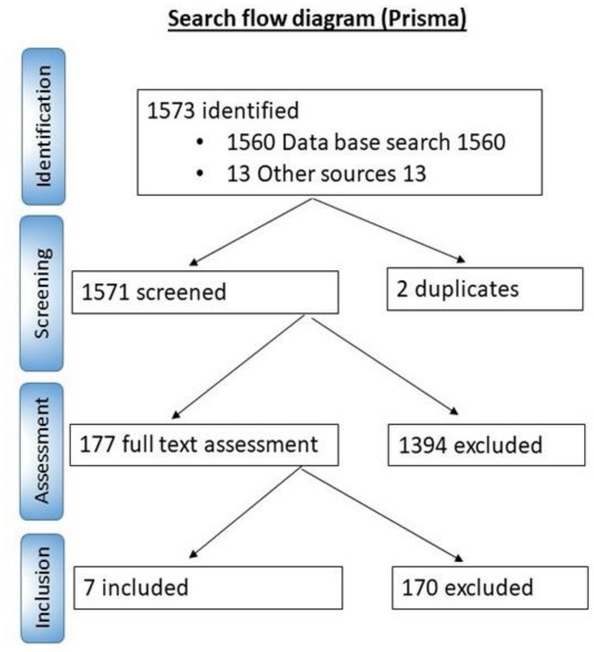
The assessment tool developed to consider exposure to different minerals under various treatment protocols, including Phase 1 and Phase 2, Plans A to C.

EXPERT PANEL

The expert panel meeting highlighted a number of key issues:

- **Water quality was not considered** when F75 and F100 products were developed
- **Osmolarity and renal solute load** (RSL) must also be considered significant
- There are **no clear upper limits** of mineral intake for SAM patients

LITERATURE REVIEW



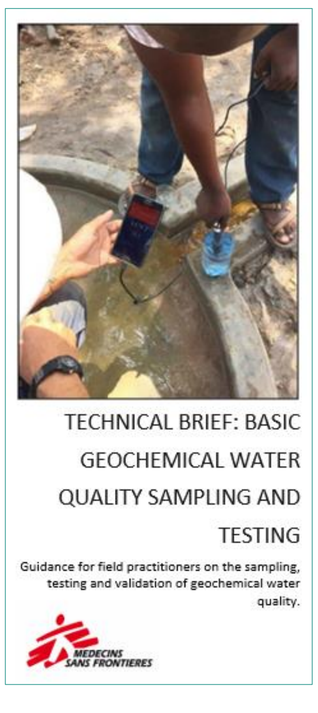
Only 7 articles were finally considered for inclusion and 3 of these were opinion pieces - **a SERIOUS KNOWLEDGE GAP!**

MEDICAL AND TECHNICAL OUTPUTS

Medical Output: Generation of an evidence matrix for all **SIX parameters of concern** giving;

- Literature findings
- All published recommended daily intakes
- Overviews of expert opinion
- Physiological/metabolic

Technical Output: Water quality testing and treatment options were explored and presented in an extensive knowledge synthesis document. WQ testing protocols were developed (see right) and new water treatment methods recommended for follow-up and potential field trials.



CONCLUSIONS

Mineral water quality is:

- **An under-considered risk in ITFCs**
- **Potentially related to adverse treatment outcomes in SAM patients**
- **Poorly understood and lacks proper guidance**
- **Important to other clinical realms, e.g. neonatology and antenatal care**

ACKNOWLEDGEMENTS

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