MECHANICAL INDEX LIMITS ARE BEING EXCEEDED.

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Introduction:

Despite reliance on manufacturer pre-sets, the operator is ultimately in control of balancing safe exposure, with adequate imaging [1]. Eye and lung ultrasound examinations involve tissue that is potentially sensitive to the mechanical effects of ultrasound, leading to stricter MI limits. Knowledge of ultrasound safety limits, particularly in non-routine operators, is lacking [2]. With the widespread use of point-of-care ultrasound (POCUS), we have undertaken an audit covering main radiology and acute care departments, to determine whether the current practice matches that of the more stringent recommended MI limits.

Criteria:

100% eye ultrasound examinations should have: **MI < 0.23** [3].*

100% lung ultrasound examinations should have: **MI < 0.4** [4]**.****

The Audit:

Aim:

Assess **local compliance** to the **stricter MI limits** imposed upon **eye and lung** ultrasound examinations.

1. Method:

Following local ethics approval, a **retrospective PACS search** of lung and eye ultrasound examinations was performed. Per study, the **Maximum MI** was noted alongside pre-set and MI-influencing parameters (frequency, acoustic power, imaging mode).

Audit timescales were chosen due to frequency of examinations performed at the trust.

: 2010 – 2020

: 2020**

2. Results:

MI_{mean} = 0.6, ***~ 2.5x* MI limit**.
1 suitable examination, *MI < 0.23.*
3 ocular presets, **all** with an **MI > 0.23**.
10 non-ocular presets chosen by users.

MI_{mean} = 0.5 for **1** lung preset in A&E (*within 2020 specified MI –date of scan*).
0 lung presets across radiology.
16 non-lung presets chosen by users.

3. Next Steps:

Reduce risk of overexposure due to inadequate pre-sets and/or parameters chosen.

Intervene:
Using the recorded MI-influencing parameters:

i. Standardise existing ocular presets.
ii. Create suitable lung preset (**Radiology**).
iii. Optimise lung preset (**A&E**).
iv. Develop training module for users (All).

Re-audit:
Assess changes 1-year post-intervention.

Eye – Preset	0.1	0.5	0.6	0.7	0.8	1	1.1	Total per preset
MSK			2					11%
MSK General				1				5%
MSK Superficial			1	1				11%
Neck			1					5%
Sm Prt Sup		1						5%
Small Parts			3					16%
Small Prt Sup				1				5%
SmPrt Sup			1					5%
Superficial						1		5%
Venous			1					5%
Eye					1		1	11%
Occular				1				5%
Orbits	1	1						11%
Total per max MI	5%	11%	47%	21%	5%	5%	5%	n = 19

Fig 1a: *Non-specialist ophthalmological (A&E) examinations between 2010-2020.*

MI Scale:

Within MI limit.

Above MI limit.

Between MI limits from differing bodies.

Radiology – Preset	0.13	0.3	0.6	1.1	1.2	1.3	Total per Preset
Abd			1				3%
Abd Gen				2	2	1	15%
Abdomen					17		52%
Adbomen					1		3%
Adult Echo						1	3%
Intervent				2			6%
MSK Gen		1					3%
MSK Sup	1						3%
PedAbdo			1			1	6%
SVEIN					1		3%
Thyroid			1				3%
Total per max MI	3%	3%	9%	12%	64%	9%	n = 33

Fig 1b: *Radiology pleural examinations across 2020.*

A&E – Preset	0.4	0.5	0.6	0.7	0.8	0.9	1	1.2	1.3	Total per Preset
AAA			1							2%
Abdomen						2				4%
Cardiac							1	2	2	9%
FAST		2	6							15%
MSK		1	1							4%
Nerve 0-4cm			1							2%
Small Parts				1						2%
Lung	3	14	7	2	2	6				63%
Total per max MI	6%	31%	30%	6%	4%	15%	2%	4%	4%	n = 54

Fig 1c: *A&E pleural examinations across 2020.*

Fig 1a-c: *Heat maps depicting the frequency of examinations at each maximum MI per pre-set, across A&E ophthalmology* **(Fig 1a)**, *radiology pleural* **(Fig 1b)** *and A&E pleural* **(Fig 1c)** *examinations.*

Conclusions:

MI limits are routinely being exceeded. There is little variation between POCUS (A&E) and radiology settings, suggesting this is more of a global issue than due to non-routine use. Intervention is required to ensure safe exposure of all patients, with preset alteration and dedicated training to safeguard image quality requirements whilst reducing patient exposure.

References:

[1] BMUS. Guidelines for the Safe Use of Diagnostic ultrasound Equipment. 2009.
[2] Verma P.K.. An Update from the BMUS Physics & Safety Group. Paper session presented at: IPEM Ultrasound Update 2023. 2023. Leeds.
[3] Kollmann C., Jenderka K.., Moran C.M., Draghi F., Jiminez Diaz J.F., Sande R. EFSUMB Clinical Safety Statement for Diagnostic Ultrasound (2019 revision). Ultraschall in Med. 2020; **41**:387-389.
[4] Demi L. et al. New International Guidelines and Consensus on the Use of Lung Ultrasound. J. Ultrasound. Med. 2022; **42**(2): 309-344.

*** :** BMUS limits ophthalmological examinations to MI = 0.3 [1]

****** : Reduction in pleural MI limit occurred during audit analysis period (0.7 in 2020 [1] to 0.4 in 2023 [4]).