University of Essex

The measurement of interface pressure applied by sports compression garments:

A comparative study of two portable devices

Chris McManus, ICC Annual Meeting, Gothenburg, Sweden

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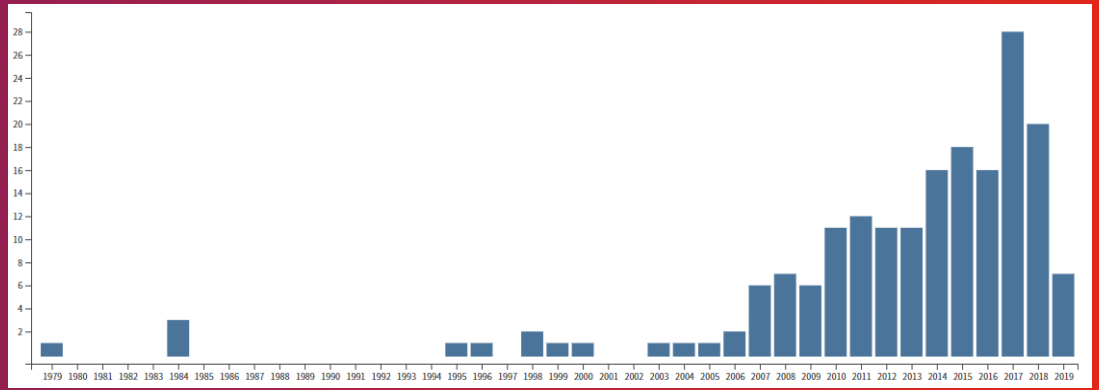
Sports compression is growing

Sports compression wear and shapewear market is expected to reach $5.5 billion by 2022

(Allied Market Research, 2016)

Number of publications relating to ‘sports compression AND exercise’



Evidence is conflicting

Prevalent among elite and recreational athletes yet evidence for enhanced athletic performance remains limited.

Heterogeneity between studies may mask any true efficacy of compression (Beliard *et al.*, 2014)

Until standardised, furthering understanding of dose-response will be a challenge

Research aim and objective

Assess the validity of two commercially-available devices *in-vivo* by comparing pressure measurements against a reference standard

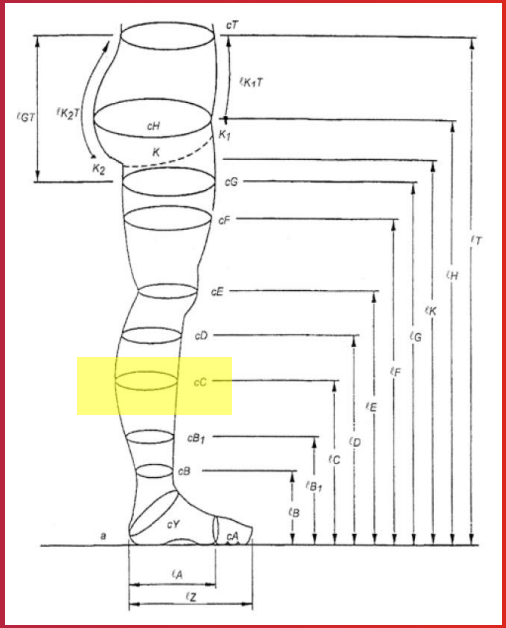
- Identify devices with acceptable criterion validity,
- Identify appropriate anatomical orientation of assessment
- Contribute towards standardised guidelines

The compression garments

(1) Calf stockings (65% nylon, 35% elastane) and
(2) Long tights (76% nylon, 24% elastane)

Elicit range of pressure reflective of lower body sports compression

Maximum calf girth (Location C);
- commonly cited in both medical and sports compression literature



Reference standard - HOSY

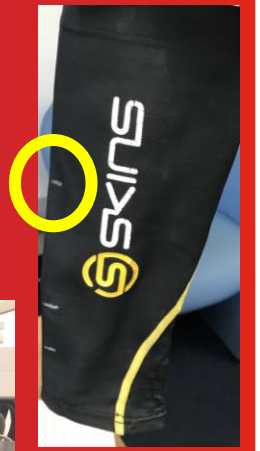
Used for medical garment validation/classification under current German standards (RAL GZ 387/1,2) (*and proposed as European standard)*

TEM = 0.5 mmHg

CV = 5.8%

a priori thresholds for acceptable validity defined as;

- level of significance *P* >0.05,
- mean bias of ±2 mmHg and
- limit of agreement ±5 mmHg (of the mean bias).



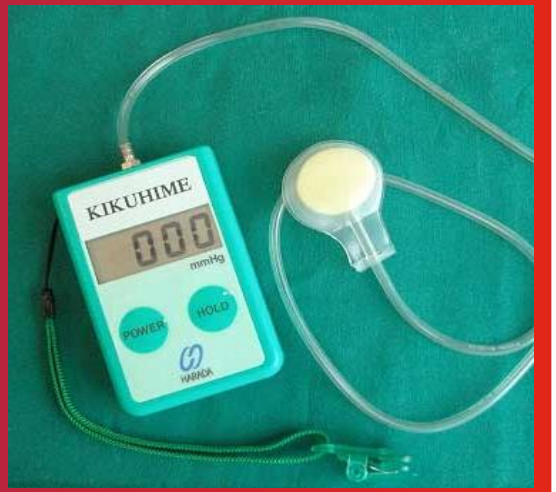
Portable devices

PicoPress;

- 5 cm circular bladder
- Air-displacement acting on pressure transducer
- 1 mmHg resolution

Kikuhime;

- ~3 cm oval bladder
- Air-displacement acting on pressure transducer
- 1 mmHg resolution

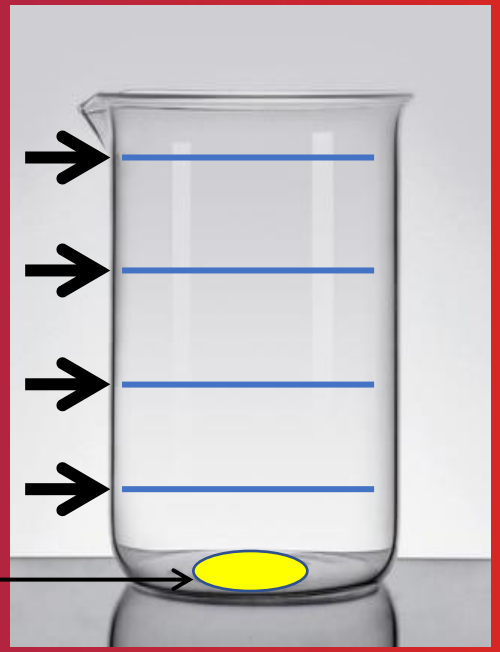


Water column assessment

- Certify measurement linearity and correlation with hydrostatic pressure
- Quick and in-expensive method
- Depth of water (mm) to achieve the target pressures calculated using the following equation,

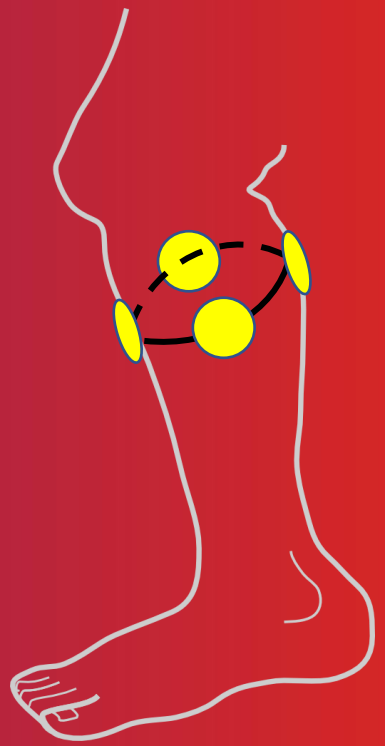
a mmHg = b mmH_2O x [7.356 x 10^{-2}]

- 5 repeated measures at each depth



In-vivo assessment

- Twelve recreationally active males (19.1 ± 1.0 y.)
- Maximum calf girth between 37 – 40 cm *(aligned with HOSY minimum and maximum elongation profile)*
- Interface pressure measured three times at;
  - anterior,
  - posterior,
  - medial,
  - lateral orientation of the maximum calf girth
- Fifth value calculated as the average of all four orientations



Individualised HOSY values

- Linear regression to predict individualised IP based on minimum and maximum elongation during HOSY assessment

- Calf stockings; $y = 0.8667x - 12.77$
- Long tights; $y = 0.62x - 10.32$.

- Regression equation used to determine IP by factoring individuals calf circumference
- Estimated HOSY IP;

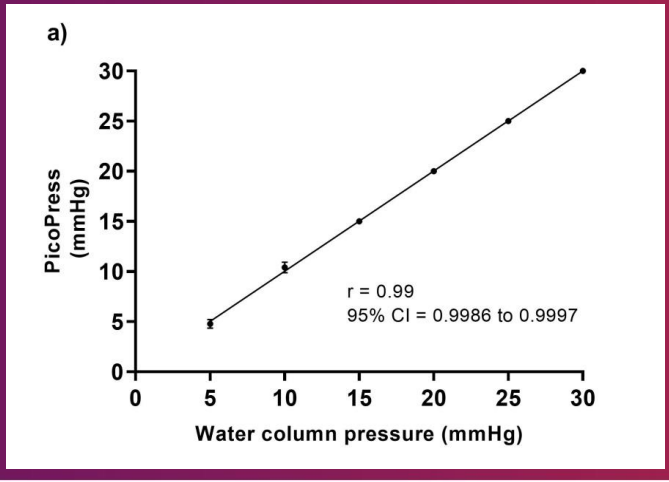
  - **Calf stockings = 20.1 mmHg [19.5, 20.8]**
  - **Long tights = 13.1 mmHg [12.6, 13.6]**

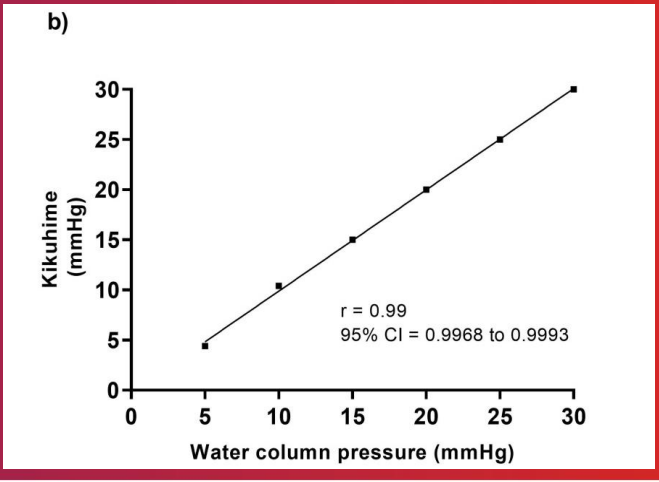
Results – water column method

Linearity and correlation coefficients for (a) PicoPress and (b) Kikuhime device.

Findings replicate previous results for Kikuhime and PicoPress (r = >0.9)

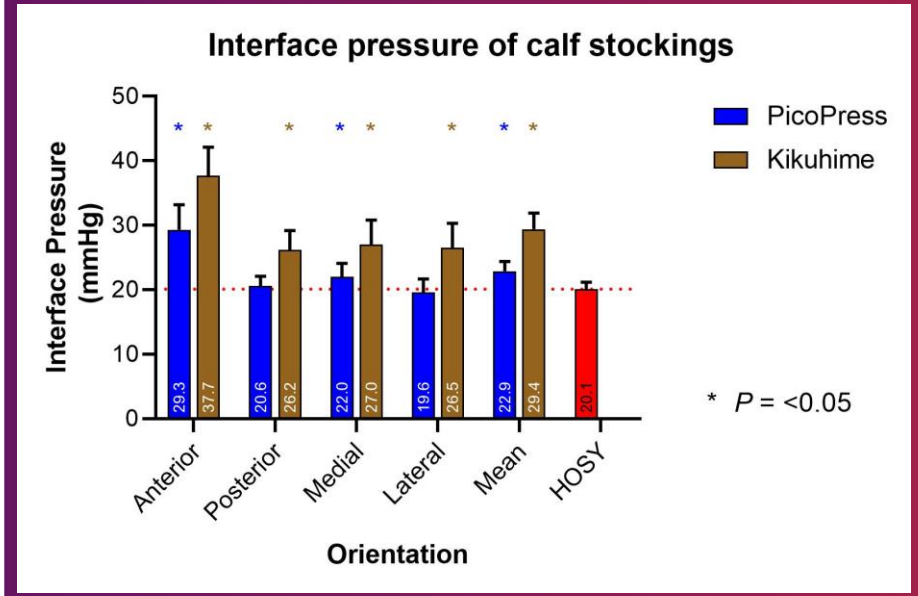
(Chassagne *et al.,* 2015; Van den Kerckhove *et al*., 2007; Brophy-Williams *et al*., 2013)

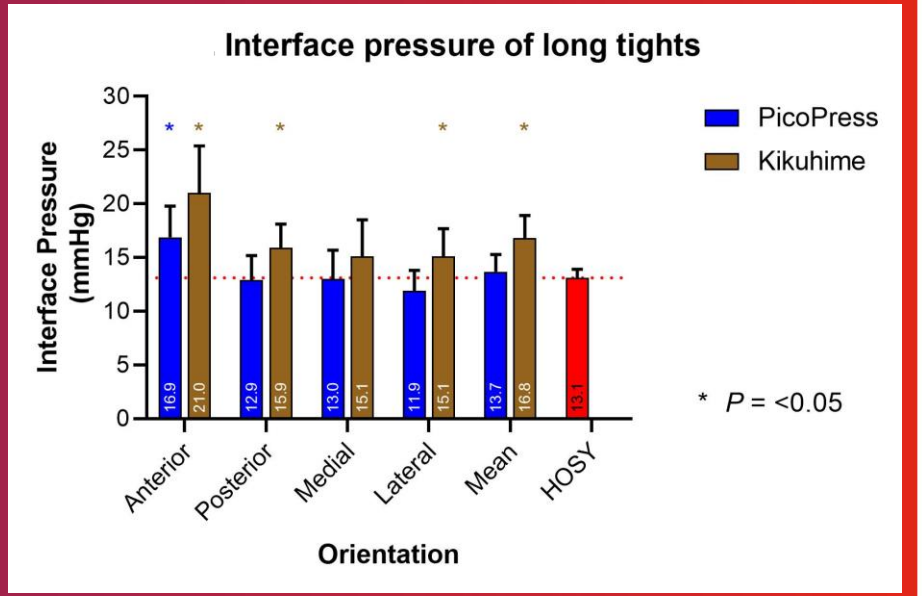




Results – *In-vivo* comparison

A-priori thresholds for acceptable validity were defined as;
- level of significance *P*>0.05,





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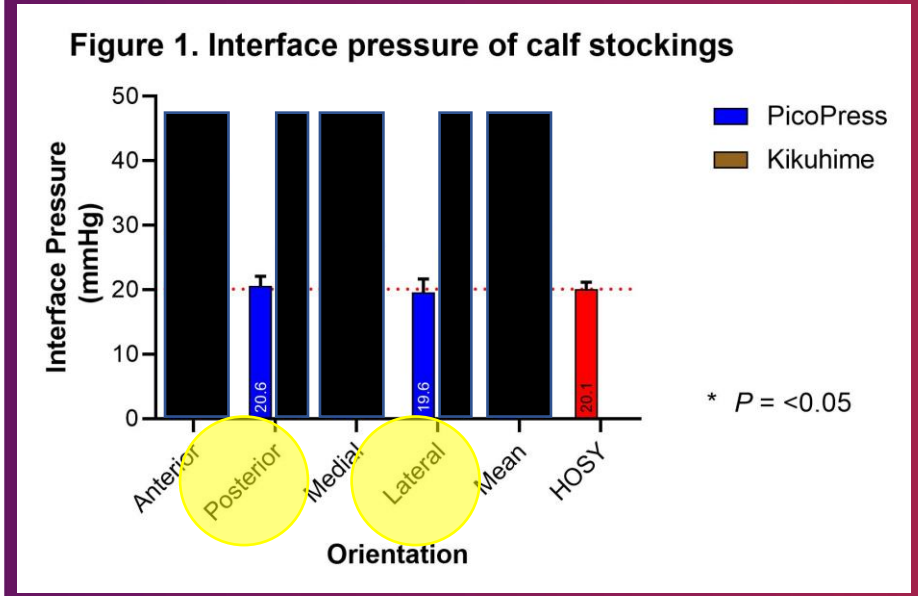
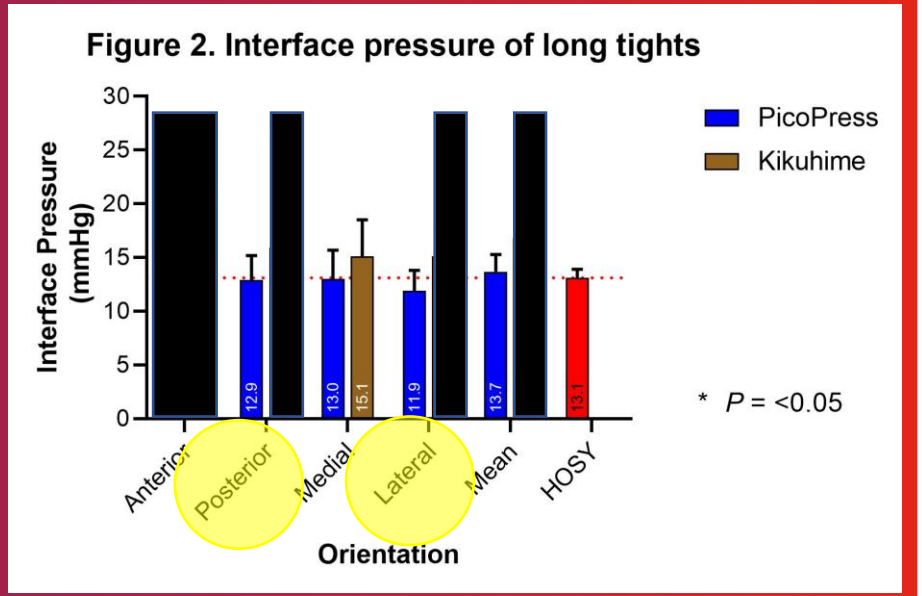
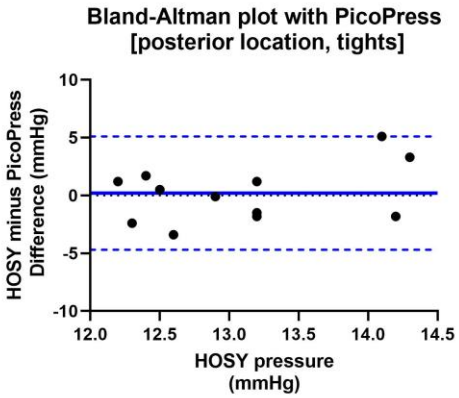
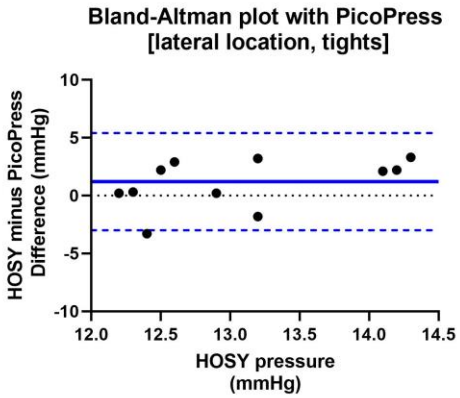


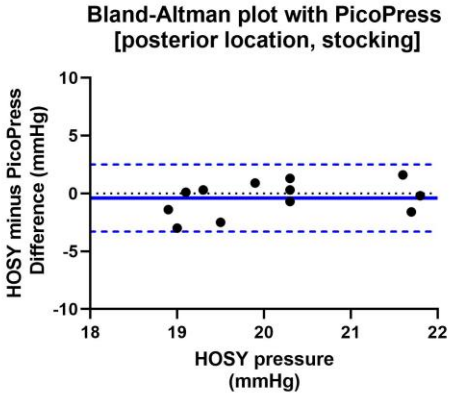




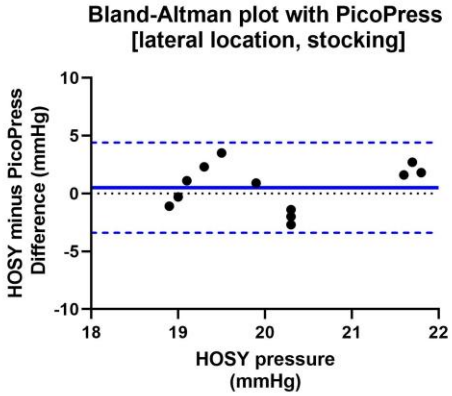
Bias = 0.2 ± 2.5; 95% CI = -4.7; 5.1
Slope [95% CI] = 1.3 [-0.9 – 3.4]



Bias = 1.2 ± 2.1; 95% CI = -3.0; 5.4
Slope [95% CI] = 1.3 [-0.5 – 3.1]



Bias = -0.4 ± 1.5; 95% CI = -3.3; 2.5
Slope [95% CI] = 0.5 [-0.4 – 1.4]



Bias = 0.5 ± 2.0; 95% CI = -3.4; 4.4
Slope [95% CI] = 0.4 [-0.9 – 1.7]

A-priori thresholds for acceptable validity were defined as;

- level of significance >0.05, ✓
- mean bias of ±2 mmHg and ✓
- limit of agreement ±5 mmHg (of the mean bias). ✓

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Discussion

Water column method;

- Excellent correlation does not = criterion validity
- Should not be used in isolation
- Offers a simple tool to identify if inherent malfunctions exist

Sports Eng
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RESEARCH PAPER

Evaluating the Kikuhime pressure monitor for use with sports compression clothing

N. Brophy-Williams · M. W. Driller ·
S. L. Halson · J. W. Fell · C. M. Shing

2.2 Water column (gold standard measure used for validity)

The pressure sensor was placed at the bottom of a 160-cm-tall clear cylindrical container. A steel measuring tape was attached to the outside of the cylinder, before it was filled

Discussion

In-vivo comparison;

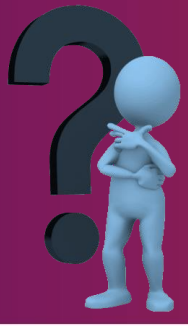
- Fundamental differences between portable devices compared with a reference device

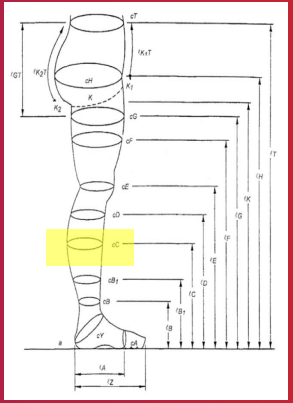
- Kikuhime overestimated interface pressures in both garments and at all anatomical sites (risk of misclassification of compression hosiery)

Discussion

Considerations;

- The garments may not reflect the range of fabric compositions used for sports compression
- Caution when extrapolating the present findings with alternative fabrics.
- Only maximum calf
- Only vs. HOSY (not HATRA, MST Pro etc.)





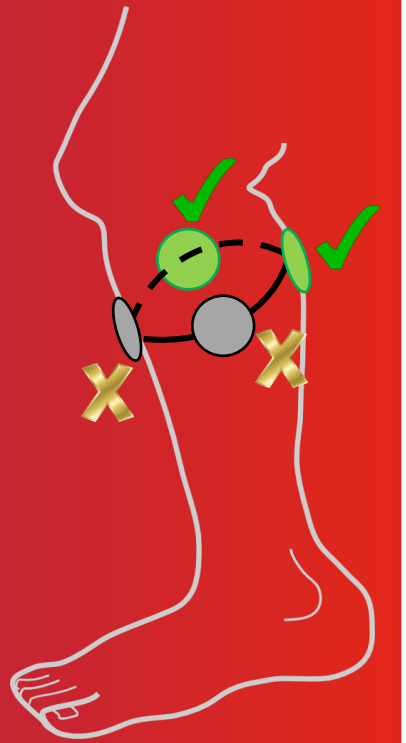
Conclusion

The findings provide guidance in terms of a standardised method to measure pressure *in-vivo*, shedding light on optimal;

- device choice
- location of assessment
- anticipated bias

Discrepancies – Future guidelines facilitate homogeneity in the method of pressure assessment

Ultimately progress the understanding of the bio-physical impact of interface pressure on physiological response and performance outcomes >> Dose-response



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