EVALUATING PATIENT HEIGHT:

Ultrasonic Measuring Stations vs. Mechanical Stadiometers

The accurate assessment of patient height is one of the key measurements in patient care.

Mechanical stadiometers, commonly referred to as height rods, have long been the gold standard for hospitals and doctor's offices when measuring patients. In recent years, ultrasonic measuring stations (or "sonar") have been positioned as alternatives to their mechanical counterparts.

Independent research regarding the accuracy of ultrasonic measuring stations in assessing patient height under real-world variables has not been available, making it difficult to determine the value and efficacy of replacing mechanical height rods with stadiometers using ultrasonic technology.

To confirm whether ultrasonic measuring stations are as accurate as mechanical height rods in the presence of real-world variables, an independent study was conducted by Kaleidoscope Innovation, a full-service insights, design and development firm.

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Do Ultrasonic Measuring Stations Accurately Assess Patient Height?

Existing research did not thoroughly test ultrasonic measuring station performance in the presence of real-world variables that can impact the accuracy of measurements.[1]

It is difficult for hospitals and doctor's offices to adequately weigh the value of ultrasonic measuring stations relative to their greater costs without knowing if ultrasonic technology can match the level of accuracy mechanical height rods are able to achieve. Therefore, independent testing of the accuracy of ultrasonic measuring stations is essential for potential adopters to make an informed decision when considering to replace their mechanical height rods.

Height Measurement and Ultrasonic Technology

Inaccurate Height Measurements Can Lead to Incorrect:

- medication dosages
- calculation of BMI and BSA
- tracking of child development
- diagnosis of degenerative conditions

The Importance of Accurate Height Measurement

Without an accurate measurement of a patient's height, the quality of healthcare the patient receives can suffer. A number of healthcare issues can arise from inaccurate height measurement including: incorrect calculation of body mass index (BMI) and body surface area (BSA), leading to erroneous assessment of procedures and/or dosing of prescription medication, improper tracking of children's development and misdiagnosis of degenerative conditions in elderly patients.

Mechanical height rods have long been the de facto height measurement tool in hospitals and doctor's offices due in large part to a simple, intuitive, cost-effective design that minimizes interference from real-world variables. The accuracy of mechanical height rods in determining patient height has made them indispensable to healthcare providers.

Recently, ultrasonic measuring stations have been introduced as an alternative to mechanical height rods. The new technology enables height measurements to be taken without the need for a mechanical arm, which can provide potential benefits that include saving time, improving hygienic conditions and reducing the possible need for breakage repair.

Despite these potential benefits, the core function of ultrasonic measuring stations is accurate and consistent determination of patient height. Any potential benefits ultrasonic measuring stations provide are secondary to the ability of these stations to accurately measure patient height with the same degree of precision as mechanical height rods.

[1] V. Watt, M. Pickering, J. K. H. Wales. A comparison of ultrasonic and mechanical stadiometry. BMJ Journals. https://adc.bmj.com/content/78/3/269 Accessed January 8, 2019.

How Does Ultrasonic Technology Work?

Ultrasonic measuring stations assess the amount of time it takes for the sound wave to leave and return after bouncing off the target being measured. This time is then converted to a corresponding height measurement.

Using sound waves in this manner, ultrasonic measuring stations can suffer from potential accuracy issues in real-world use. For example, ultrasonic measuring devices require their sound waves to strike large, smooth surfaces in order to achieve the most accurate, consistent measurements possible. Thus, their measurements might decrease in accuracy if used to record the heights of patients with smaller head sizes or even thick, curly hair.

Additionally, because the sound waves emitted by ultrasonic measuring stations naturally spread out in a cone shape, the farther they travel, the greater the possibility for interference from outside sources. This potential interference could result in less accurate height measurements of patients who are shorter and thus farther from the source of the spreading sound waves.

Equally important, the sound waves being used are invisible and the operator can never be certain what the device is actually measuring.

When considering the potential issues tied to their intrinsic functions, the necessity of thoroughly testing the performance of ultrasonic measuring stations in the presence of real-world variables becomes apparent. Kaleidoscope Innovation's independent testing stands as the best assessment to date of the accuracy of patient height measurements taken with ultrasonic measuring stations.

> ***"By using sound waves in this manner, ultrasonic measuring stations could suffer from potential accuracy issues in real-world use."***

Testing the Accuracy of Ultrasonic Measuring Stations

To ensure the independence of its study, Kaleidoscope built a mechanical height rod in-house and used the measurements of this mechanical height rod as the absolute height against which the ultrasonic measuring stations were tested.

In order to effectively replicate these real-world variables,

human subjects of differing heights, head sizes and hair types

were measured twice, at different times of the day, with multiple ultrasonic measuring stations.

Kaleidoscope also identified key factors to include in its testing that could impact the accuracy of the ultrasonic measuring stations when used in real-world settings, such as hospitals and doctor's offices. These factors include differences in the height, head size, hair type, head orientation and head positioning of measured patients.

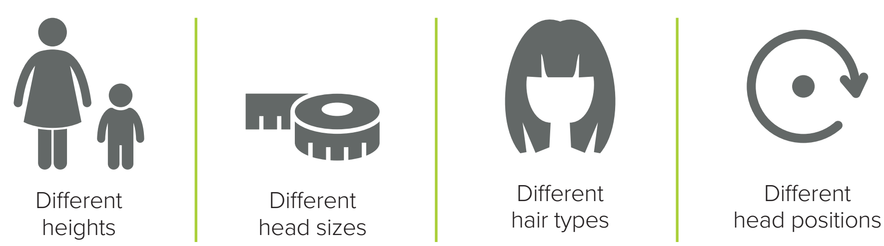
In order to effectively replicate these real-world variables, human subjects of differing heights, head sizes and hair types were measured twice, at different times of the day, with multiple ultrasonic measuring stations. For further consistency, mannequins were also used as subjects, one with a head bigger than 50 percent of all male heads, and the other with a head bigger than 90 percent of the male head population. The mannequins were also tested in different wigs to simulate a variety of hair types, ranging from bald (no wig) to thick, curly hair.

Additionally, orientation testing was conducted with the aim of recording any deviation in the measured height of subjects if they face in different directions relative to the ultrasonic measuring station. For greater precision in the test results, a mannequin head was used in conjunction with a fixture that allowed the head to be placed in various orientations from 0 degrees (facing away from the machine) up to 315 degrees.

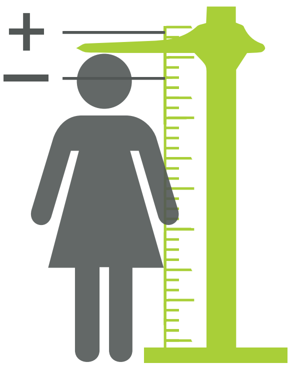
With regards to head positioning/orientation, testing of the ultrasonic measuring stations was conducted in line with the orientation study by using a mannequin head to help ensure consistency. Use of the mannequin head removed possible variations that could be introduced by human subjects, such as slouching and tilted necks. Fixtures were used in offset testing that allowed the mannequin head to be accurately positioned closer to and further from the central plane of the ultrasonic measuring stations in set increments.

Kaleidoscope Innovation's assessment of the performance of ultrasonic measuring stations led to a clear conclusion. When evaluated under a range of real-world variables, the ultrasonic measuring stations consistently failed to meet the level of accuracy achieved by the mechanical height rod against which they were tested.

Real-world factors that can interfere with ultrasonic accuracy:



Performance Shortcomings of Ultrasonic Measuring Stations



IN ONLY

3 of the 62 measurement sets (5%)

did ultrasonic measuring stations measure the subject height exactly.

IN

6 of the 62 measurement sets (10%)

the ultrasonic measuring stations deviated in their measurements from the actual subject height by more than 1 cm.

When evaluating the data gathered from Kaleidoscope's study, several conclusions can be drawn regarding the relative inaccuracy of the ultrasonic measuring stations.

Of 42 measurement sets involving human subjects, the ultrasonic measuring stations averaged a difference of 0.5 cm from the actual height of the subject. The greatest single deviation from actual height reached 1.6 cm.

To further expand upon the results of the ultrasonic measuring stations as compared to the mechanical height rod, the ultrasonic measuring stations measured subject height below actual height in 24 of the 42 measurement sets.

When accounting for all 62 measurement sets across Kaleidoscope's study, including those involving both human and mannequin subjects, the results remain consistent. In only 3 of the 62 measurements sets (5 percent) did ultrasonic measuring stations measure the subject height exactly. Further, in 6 of the 62 measurement sets (10 percent), the ultrasonic measuring stations deviated in their measurements from the actual subject height by more than 1 cm.

Lastly, though the study established no clear correlation between orientation and deviation in height measurement, results from the offset analysis indicated a high impact on the accuracy of the height measurement for the subject with thick, curly hair owing to non-centered placement in the ultrasonic measuring station.

When the mannequin with thick, curly hair was placed at a distance of 2.5 cm and 3.5 cm away from the center planes of the ultrasonic measuring stations, its height was measured in error of 3.6 cm and 4.35 cm, respectively.

These results show height measurements taken by ultrasonic measuring stations in real-world settings can be significantly less accurate and less consistent for some patients based on their hair type or if they did not stand precisely along the center planes of the stations.

Mechanical Height Rods Remain the Gold Standard

Ultrasonic systems are significantly less accurate than mechanical height rods

Despite being positioned as a potential replacement for mechanical height rods in settings such as hospitals and doctor's offices, ultrasonic measuring stations had not been adequately studied to determine their accuracy in measuring patient heights under real-world variables.

To address the lack of research on the accuracy of ultrasonic measuring stations, Kaleidoscope Innovation conducted a thorough, independent study of leading ultrasonic measuring stations. The data gathered from Kaleidoscope's study leads to a clear conclusion — the ultrasonic measuring stations tested consistently failed to match the precision of a mechanical height rod and returned results that do not meet the clinical standards required in professional medical environments.

With accurate height measurements playing a vital role in the quality of care afforded to patients, the results of Kaleidoscope's study highlight the risks of replacing mechanical height rods with ultrasonic stadiometers, especially given the substantially higher cost of ultrasonic measuring stations.

Taking into account the inaccuracies inherent in ultrasonic measuring of patient height and the additional costs of ultrasonic measuring stations, the continued use of mechanical height rods over ultrasonic measuring stations to measure patient height remains the most consistent, accurate and cost-effective option for healthcare providers who seek to offer their patients the highest quality care.

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