Droplet Size Testing

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Introduction

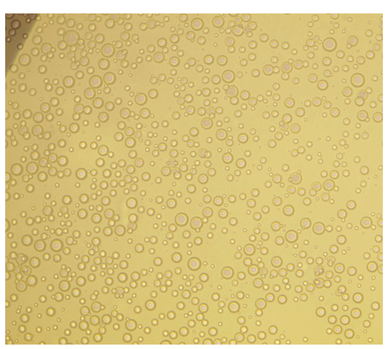
This study analyzes droplet sizes generated by nebulizers by collecting aerosolized liquid on microscope test slides and processing microscope images with MATLAB to quantify droplet distributions. Measurements are compared to the target droplet size range required for effective nebulization, since droplets outside this range can reduce respiratory delivery efficiency. Results help evaluate nebulizer performance and ensure droplets meet specifications for optimal aerosol behavior. It is important to achieve the correct droplet size range to ensure medication can be effectively delivered to the lungs. This improves treatment efficiency and consistency in respiratory drug delivery systems.

Procedure

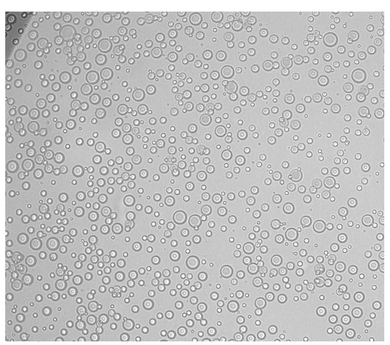
Methodology

The MATLAB function processes an input image to detect and measure droplets by first converting the image to grayscale and enhancing its contrast so the droplets stand out more clearly. It then segments the droplets by creating a binary mask, either by detecting bright regions, enhancing dark regions, or automatically choosing the best method based on how circular and well-defined the detected shapes are. The mask is cleaned to remove noise and improved using a watershed algorithm to separate overlapping droplets. Each detected droplet is then measured using its equivalent diameter and converted from pixels to microns using the conversion found at the specific microscope magnification. Finally, the function outputs the results in a table, displays visual overlays and a size distribution histogram, and saves the measurements to a CSV file for further analysis.

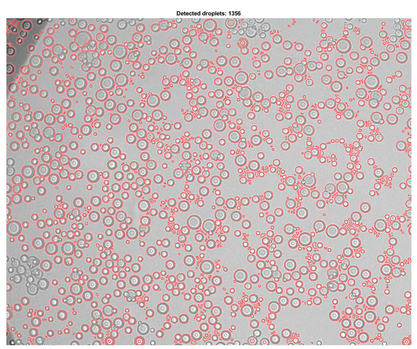
Results



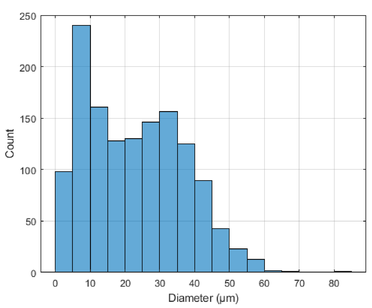
Raw Image



Filtered Image



Droplets Detected



Droplet Distribution

Analysis

During microscopy, the video function was used to observe droplets deposition onto the test slide in real time. This allowed for identification of whether droplets were formed as individual particles or as clusters on the slide surface. Droplet clustering is significant because, during MATLAB image processing, the filtering algorithm may interpret overlapping droplets as a single larger droplet. This can introduce outliers that increase the measured droplet size range and distort the overall size distribution. By visually confirming the presence of clustered droplets, these outliers can be reasonably identified and excluded from the dataset. Removing these values provides a more accurate and representative droplet size distribution, allowing for a more reliable evaluation of nebulizer performance and improved comparison to the target droplet size range required for effective aerosol delivery.

Conclusion

Overall, the droplet testing procedure and MATLAB image analysis successfully provided a practical alternative to specialized droplet measurement equipment. The measured droplet size distributions could be compared to the target range required for effective respiratory drug delivery. Although limitations such as droplet clumping and background noise can affect individual measurements, these outliers are identifiable through visual inspection and can be removed without significantly impacting the overall distribution. This method provides a repeatable approach for evaluating nebulizer performance and verifying that aerosol droplets fall within the appropriate size range for efficient lung deposition. The results demonstrate that accurate droplet characterization can be achieved using accessible tools, supporting consistent performance evaluation of aerosol drug delivery systems.

Acknowledgments

A huge thank you to Dr. Robert Bittle and the Senior Design team for their unwavering support and guidance throughout this project. Special thanks to Breezy Thoughts for the project opportunity and the chance to develop this solution.