Machine Learning-Enabled Renal Ultrasound View Labeling to Expand Use of Point-Of-Care Imaging in Community Settings

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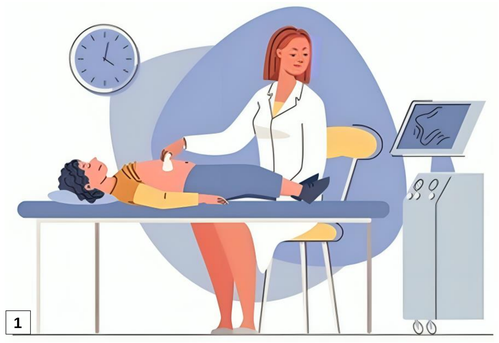
Point-of-Care Ultrasound (POCUS) is **widely available** but **under-used in community settings**.

Real-time renal view labeling can boost its use in the **community** for **monitoring and diagnosing urology conditions in children.**

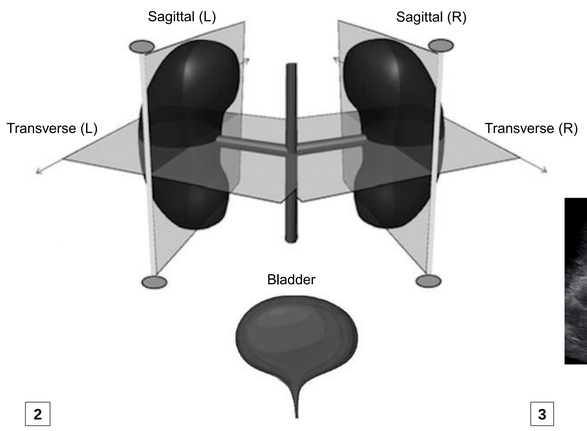
Challenges in Community Health

1. Lack of paediatric sonographers
2. Lack of paediatric urologists



1

View Labels

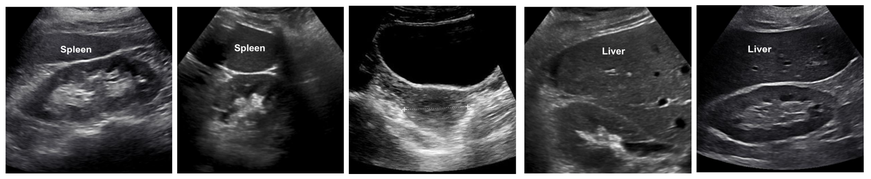


2

Challenges in Automated View Labeling

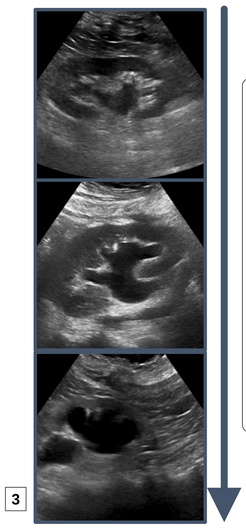
1. Inherent label uncertainty between views
2. Invariance to different ultrasound devices
3. Robustness across varying severities of renal diseases

Example Images



3

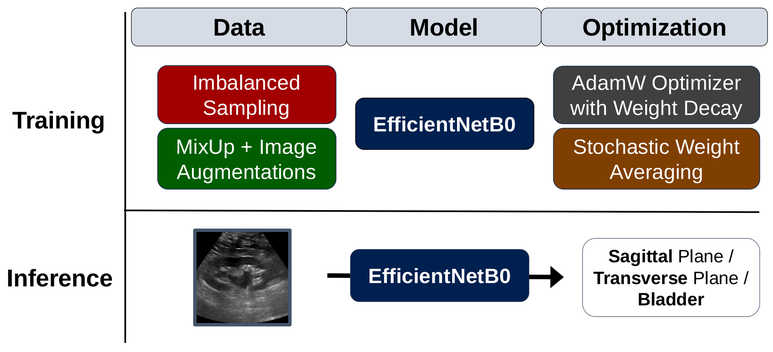
Left Kidney (**Sagittal**) | Left Kidney (**Transverse**) | **Bladder** | Right Kidney (**Transverse**) | Right Kidney (**Sagittal**)

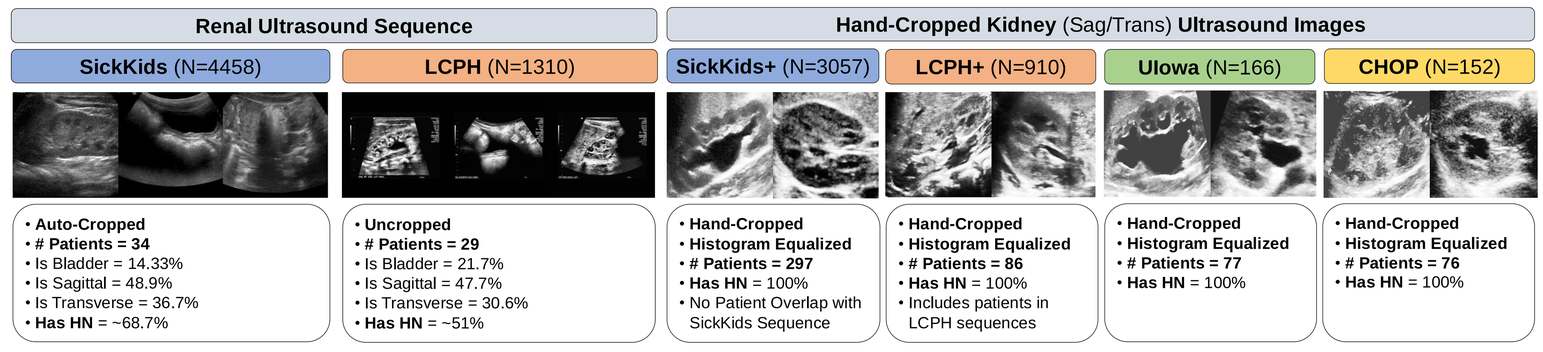


3

We develop **RenalView**, a **deep-learning based view labeling algorithm**, using **pediatric renal ultrasound sequences** at **SickKids**.

We evaluate its ability to **generalize across data from multiple institutions**.





RenalView generalizes well to external ultrasound sequences.

Confident predictions show promise in **identifying high-quality views**.

To assess for **shortcut learning**, we evaluate **RenalView** on **tight kidney crops** and show **sustained performance**.

Future Directions

1. Explore **uncertainty-based methods** to improve **detection** of **high-quality views**
2. Evaluate **RenalView** performance on children with **rarer renal pathologies**
3. Evaluate **RenalView** in **community-acquired** ultrasound and during **real-time** acquisition of pediatric renal ultrasound
4. Test and deploy **RenalView** in **remote indigenous communities** in **Canada**

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Figure 1. **Performance on Ultrasound Sequences** from **SickKids** (Internal) and **LCPH** (External), with specific performance on **kidneys with hydronephrosis** and the **most confidently predicted view** per **side**.

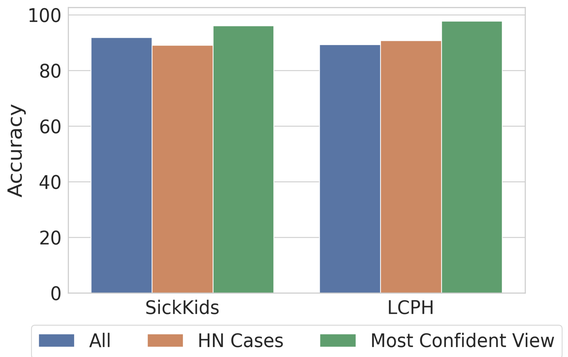


Figure 2. **Example Images** of **Most Confidently Predicted Views** in **SickKids** (Left) and **LCPH** (Right)

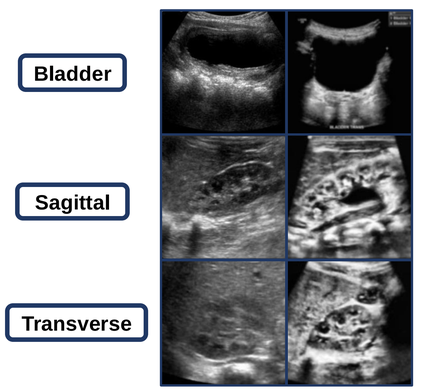
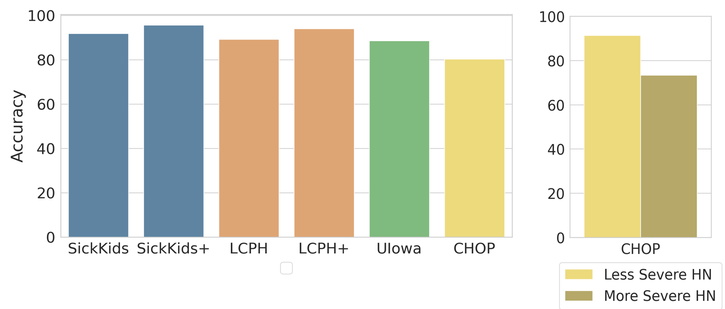


Figure 3. **Performance on Ultrasound Sequences and Ultrasound Images** from **SickKids, LCPH, Ulowa and CHOP.** Performance **improves** for **SickKids** and **LCPH** kidney crops, while it underperforms for **CHOP** on more **severe hydronephrosis** cases



REFERENCES
[1] Image taken from Shutterstock
[2] Image adapted from *Tsai HY, Lee MH, Chen HC, Chen HC, Guh JY. Sagittally malrotated kidney: a case series of two patients. Surg Radiol Anat. 2015*
[3] Image adapted from Koratala, A. POCUS Gallery. Renal Fellow Network.