studies.[1,3] For example, we observed a higher number of patients with no or 1 indentation compared to proportions reported previously. These differences can be explained by study methodology, definition of indentations, and inclusion of patients with only secondary MR. In addition, the diverse population served by an inner city hospital in New York City is likely underrepresented in other studies in the literature.

This study is limited by its single-center nature as well as a small sample size, and, therefore, a larger study with prospective follow-up is required to confirm these findings.

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SUPPLEMENTARY DATA

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Identifying Aortic Stenosis With a Single Parasternal Long-Axis Video Using Deep Learning

The accurate diagnosis of aortic stenosis (AS) involves both the acquisition of cardiac ultrasound images and the interpretation of these images by skilled personnel.[1] Access to such specialty care, however, may not be possible in many parts of the world, and regular echocardiographic studies can be expensive. Nevertheless, AS is a progressive disorder, and follow-up echocardiographic studies are recommended for patients with valvular disease.[2] A quick and accurate detection method, which minimizes the need for specialized clinical interpretation, would make AS screening more accessible in settings where access to clinical specialists is limited.

Conflicts of Interest: None.

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Table 1 Discriminatory ability of different models

Model	Test set size	Area under the curve (SD)
M_p	5,791	0.88 ± 0.01
M_a	3,075	0.78 ± 0.01
M_S	3,075	0.79 ± 0.01

Deep learning (DL) forms a platform for the automated evaluation of echocardiographic data. Indeed, DL models have been constructed for a variety of tasks ranging from view classification to disease diagnosis.[3,4] In the case of AS, Huang *et al.*[5] reported a DL model that classifies patients as having no AS versus mild or severe AS, using all views obtained during a routine echocardiographic study.[5] The method was developed and evaluated on a small data set (260 patients) and achieved a 90% accuracy in the classification task. We hypothesized that a single parasternal long-axis (PLAX) view could be used to identify severe AS.

To construct a DL model for identifying severe AS using a single PLAX view, we identified all echocardiographic studies performed from 2001 to 2019 at Massachusetts General Hospital and selected studies where the mean transvalvular gradient or aortic valve area (AVA) was reported by a level III trained echocardiographer. This resulted in a total number of 28,734 studies from 16,066 patients, where all studies had a reported a mean transaortic valve pressure. Out of these studies, 15,041 studies, arising from 8,749 patients, had measured AVAs. Data preprocessing and summary statistics of patients used to develop each model are shown in the Supplemental Material.

We trained and tested 3 DL models: (1) M_P: a model to identify when the mean transvalvular pressure was >40 mm Hg using all 28,734 studies; (2) M_A: a model to identify when the AVA was <1 cm^2 using 15,041 studies; and (3) M_S: a model to identify whether either the transvalvular pressure is above 40 mm Hg or the AVA is below 1 cm^2. Each model examines a single PLAX view (movie) as input and outputs a prediction. The model training procedure is described in the Supplemental Material.

Table 1 details the discriminatory ability of each model. Model M_P has better discriminatory ability relative to the other models, likely because more data were available for training this model. Sensitivity-specificity curves as well as positive and negative predictive values at different prevalence levels are shown in Figure 1A. To gauge how this model would perform in the general population, estimates of the prevalence of severe AS are needed. Several studies across different patient cohorts have estimated the global prevalence of severe AS to be between 3% and 4% in patients over 75 years of age.[6] At this prevalence level, the negative predictive value of all 3 models is more than 98%, with an 80% sensitivity.

To understand what data within a PLAX view most influence model predictions, we calculated saliency maps. Saliency map analysis is an illustrative way to reveal what regions of an image most influence model decision-making.[7] The method calculates a scalar "saliency value" for each pixel in an image, and the resulting matrix is called a saliency map. The larger the saliency value, the more important that pixel is for the model arriving at its prediction. Examples of saliency analyses are shown in

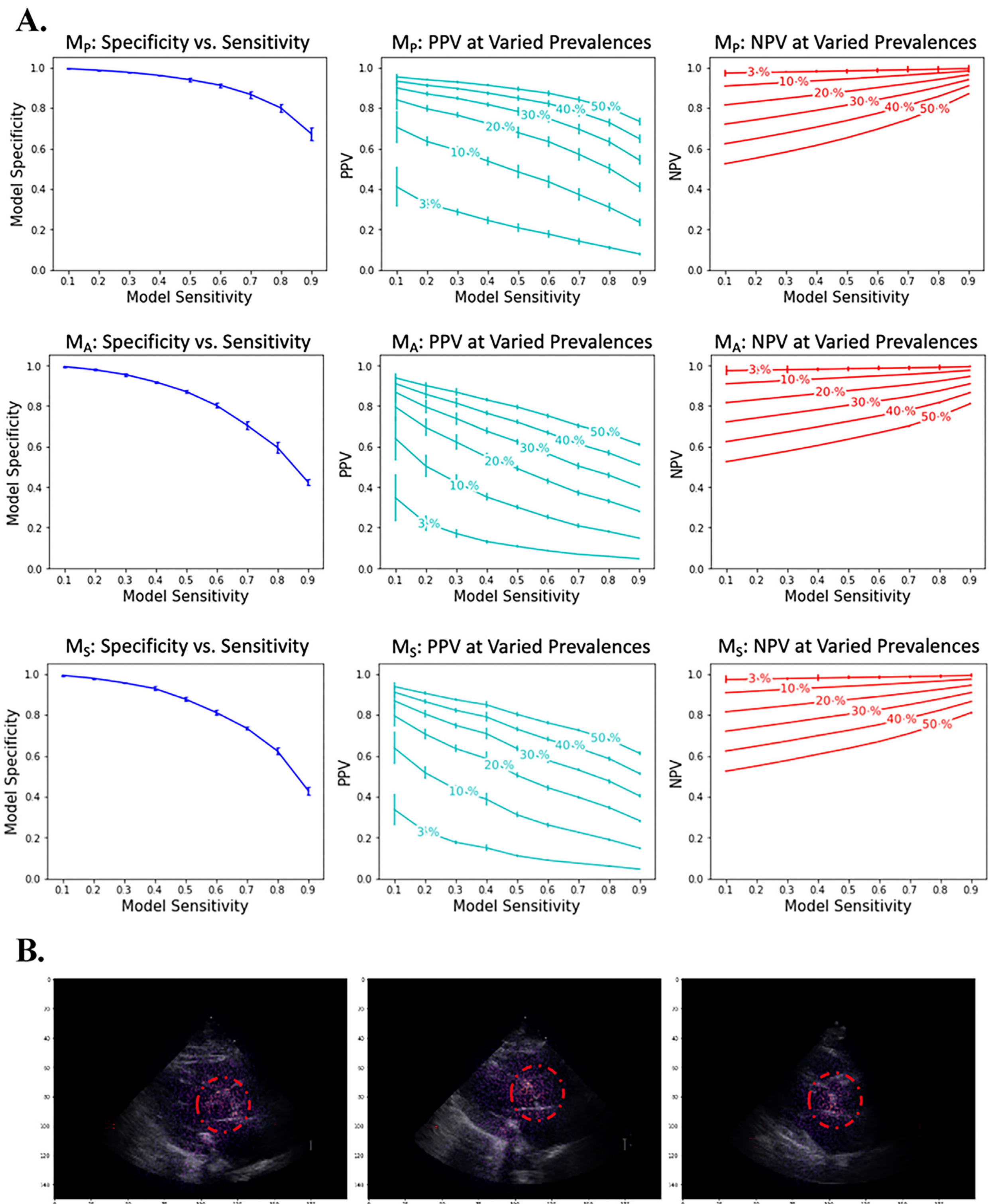

Figure 1 **(A)** Positive and negative predictive values (PPVs and NPVs) of models M_P, M_A, and M_S as a function of the underlying prevalence. **(B)** Saliency map analyses from 3 patient studies show focus area and frames of the learned model. The most focused frames are within the ejection period of a cardiac cycle, and the brightest pixels are around the aortic valve region, as shown by the *dotted circle* in the images.

highlighted compared to the background in both models. This demonstrates that DL models align appropriately with the relevant anatomic feature.

Screening for AS in patients with relevant risk factors and/or clinical exam findings suggestive of aortic valvular disease remains a mainstay of clinical care. In this study, we developed several DL models to identify severe AS patients using only a single PLAX video. All models have good discriminatory ability and have high negative predictive value at a prevalence level expected for patients over 75 years old, suggesting that these methods could be used to effectively rule out severe AS in this cohort.

The DL algorithms can be applied in an automated manner, in the context of a point-of-care ultrasound study, to facilitate screening of patients with severe AS. In addition, this screening algorithm can help sonographers and echocardiographers prioritize what studies to focus on, that is, studies that the model identifies as severe AS warrant a more thorough evaluation of the aortic valve. We have made the model generally available at https://github.com/mit-ccrg/AS_PLAX.

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Factors Associated With the Occurrence of Significant Mitral Regurgitation After Tricuspid Valve Surgery for Severe Isolated Tricuspid Regurgitation

In patients with isolated severe tricuspid regurgitation (TR), the degree of mitral regurgitation (MR) tends to be masked. Right ventricular (RV) dilation and dysfunction following chronic TR promote left ventricular (LV) underfilling and limit MR. After stand-alone tricuspid valve (TV) surgery, MR can progress as the reduced LV preload is restored.[1] In mitral valve (MV) surgery, even if TR is not severe, TV surgery is recommended if the TV annulus increases to a certain level or in the presence of moderate TR.[2] However, there is no established treatment policy for surgical correction of mild to moderate MR when performing isolated TV surgery.[3] Therefore, we aimed to identify the factors associated with the progression of significant MR in patients who underwent stand-alone TV surgery.

Seventy-one patients with isolated severe TR who underwent stand-alone TV surgery between January 2000 and December 2020 were retrospectively evaluated after excluding patients with a history of valve surgery or intervention, history of coronary artery

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