Prostate cancer management is surrounded by controversy. From the screening debate through choosing the best treatment option for localized disease, there is little consensus on the approach to the most common solid tumor in men. A variety of predictive models are being developed to assist in clinical decisionmaking.[1,2] Although transrectal ultrasound (TRUS)-directed prostate biopsies represent the "gold standard" in the diagnosis of the disease, limitations of this approach have been recognized.[3] To compensate for these limitations, the absolute number of needle cores taken has increased from 6 to 10–12 or more. TRUS enhancements such as color Doppler and the use of contrast agents hold promise, but they have not yet replaced the TRUS grayscale approach.[4]

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Artificial Neural Networks

The ANN is a specific type of computer-driven, artificial intelligence software system, based on the neural structure and function of the brain. Basic processing units called nodes simulate neurons, and weighted interconnections between the nodes simulate the basic units of the nervous system, dendrites, and axons.[5] These interconnections weigh functions as multipliers that simulate the connection strengths in the analogous biologic model. ANNs are not programmed, but are unique in that most "learn" by experience, ie, a "supervised learning" phase known as training. The ANN learning set consists of actual clinical case inputs and known outputs (ie, results). These clinical variables (in this case, data such as digital rectal exam findings, prostate-specific antigen [PSA] levels, and age) and a known pathologic outcome are presented to the ANN sequentially and repeatedly. A training algorithm automatically adjusts the connection weights, consequently changing the output values, to reduce the errors between the actual ANN outputs and the expected outputs. With training, a set of connections is developed to allow for the greatest number of correct predictions for a given training dataset. Measuring ANN Performance

Next, the system is validated with new cases to determine the accuracy of the prediction. The performance of an ANN can be measured by calculating the sensitivity, specificity, and both negative- and positive-predictive value of a specific ANN output. The overall performance may be quantified by generating a receiver-operator characteristic (ROC) curve. TRUS Images Validate Output

ANNs have great potential in the overall management of prostate cancer.[6,7] Though not directly addressed in this review, another use for ANN technology is to enhance TRUS images and identify malignant foci. In fact, one of the earliest reports of the use of ANNs in prostate cancer, published in 1992, involved the analysis of TRUS images of the prostate.[8] In this preliminary work, the ANN was able to differentiate between prostatic and nonprostatic tissues in TRUS images. Pure ultrasound radiofrequency images inputted into the ANN model for the analysis of ultrasound images of the breast, colon, prostate, and other tissues have shown strong results in the identification of malignancy.[9-11] By gathering actual TRUS images prior to radical prostatectomy and comparing these to whole-mount pathology slides, prospective libraries of prostate tissue image types have been developed and incorporated into ANNs. With such a technique, an ANN was used to identify areas suspicious for cancer in a validation set of TRUS images.[10] Preliminary data demonstrated...
that 99% of confirmed benign samples and 79% of malignant lesions were correctly classified. Of isoechogenic cancers, 97% were correctly classified by the ANN. This technology is also applicable to other modalities such as magnetic resonance and color Doppler imaging.[4,12] Automated image analysis, including pattern recognition and ANNs applied in real time to TRUS images, may successfully identify lesions that cannot be seen by the human eye. Such automated image analysis and pattern recognition, however, is currently unavailable for TRUS systems. **Predictive Modeling Tools**

As noted, predictive modeling tools are being developed to assist the clinician in the decision-making process. Traditionally, these tools have relied on solely clinical parameters (eg, PSA, clinical stage). ANN technology allows the integration of many more complex variables into this decision process. Although specific identification of malignancies on imaging studies was the first use of ANN technology, Drs. Porter and Crawford review the combination of ANNs with basic clinical parameters and ultimate diagnostic TRUS imaging and biopsy to develop predictive models for prostate cancer needle biopsy. This could be the next major advance in our ability to avoid unnecessary prostate biopsies. The integration of clinical parameters or other markers to improve the identification of prostate cancer is a basic hurdle that must be overcome. While these developments reviewed by Porter and Crawford are outstanding, they are not the final solution to the prostate cancer screening and diagnosis controversy. Many men have clinically insignificant prostate cancer at the time of diagnosis. A theoretical concern is that this elegant ANN technology may inadvertently lead to overdiagnosis of so-called autopsy cancers. Indeed, the diagnosis of the "clinically insignificant," often small-volume prostate cancers is one of the major arguments against screening for prostate cancer. These insignificant prostate cancers may never cause clinical symptoms nor result in death ("more men live with than die from prostate cancer") and might be amenable to watchful waiting approaches.[13] Whether the enhanced methods proposed by the authors cause more insignificant tumors to be detected remains to be seen. In addition, we need a technology that can differentiate the life-threatening tumors from the indolent ones even before the prostate is violated by a needle through the rectum. Could ANNs be incorporated into an imaging modality that would allow the identification of tumors and their classification as insignificant or significant? Although preliminary work has been done in identifying the aggressiveness of prostate cancer on imaging studies, this remains a challenge for the future.[14] Predictive models are becoming commonplace in the management of prostate cancer. The benefit of the ANN described by the authors is that more complex variables can be analyzed to help with decision-making in this complex disease.

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