INAHTA Briefs

Issue 2002/4

Title DNA Chips: Analysis Systems of DNA Sequence Variations

Agency CEDIT, Committee for Evaluation and Diffusion of Innovative Technologies

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Reference CEDIT Report 01.08 (in French).

Aim

This report, based on a literature review, aims to estimate the benefit of using DNA chips in a hospital diagnostic laboratory.

Conclusions and Results

Working with DNA chips requires combining different components: the chip itself with its special surface, the device for producing DNA chips by spotting the nucleic acids onto the chip or for their *in situ* synthesis, a fluidic system for hybridization to target DNA, a scanner to read the chips, and sophisticated software programs to quantify and interpret the results. Special equipment is now commercially available for each of these components. Moreover, complete systems currently commercially available should move this technology from its current standing as a laboratory-based research tool toward becoming an analytical method for clinical use.

Two primary techniques are used to prepare DNA chips:

- The *in situ* synthesis technique is based on the synthesis of nucleotides directly on the chips using a photolithographic mask. These chips need to be purchased from manufacturers, eg, Affymetrix®, which currently markets a range of GeneChips aimed at specific applications and a complete workstation.
- In the second technique, probes are prepared and spotted onto the chip array by the laboratory. Nanogen® currently markets the complete "NanoChip™ molecular biology workstation" and the cartridges containing the DNA chips. The innovative character of the current technique lies in the use of electronic addressing and hybridization, which are entirely automated. Moreover, it is the only complete workstation currently manufactured that presents such adaptable characteristics, with a particular focus on the diagnosis of rare diseases such as hereditary diseases. The limitation of the technique is actually the small number of spots (100 spots) by chip.

The DNA chip technology is currently available essentially for research applications: gene expression analysis, detection of new point mutations, insertions or deletions, detection of single nucleotide polymorphisms (SNP), etc. Diagnostic applications involve detection of hereditary or acquired (cancer) human diseases and detection and identification of microorganisms (bacteria, viruses, or parasites). DNA chips allow simultaneous analysis of a considerable number of sequences:

- Analysis of the majority of described point mutations for a single human disease, as long as all existing point mutations are known,
- Classification of individual tumors and analysis of gene mutations involved in cancer, and
- Isolation, identification, and detection of specific virulence or drug-resistance markers of microorganisms in a single step.

Numerous molecular biology methods used so far are time-consuming, whereas using DNA chips could reduce the diagnostic time from a few days to a few hours.

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Since the technology is new and essentially used in research applications, no economic evaluation has been found in literature. It has been suggested that this technology would be economically competitive for sustained use.

Recommendations

CEDIT emphasizes that DNA chips are an extremely exciting development. The evaluation of the NanoChip™ molecular biology workstation in a hospital biochemistry and genetic laboratory will be supported by CEDIT. This evaluation will first focus on human diseases with several points of mutation.

Sources of information

A literature search was performed in MEDLINE, and contacts with manufacturers and experts were also used in the assessment.

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