EVALUASI EFEK TERAPI SEL T SITOTOKSIK TERHADAP VIABILITAS DAN APOPTOSIS GALUR SEL KANKER PAYUDARA MDA-MB-231 SECARA *IN VITRO*

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ABSTRAK

Latar belakang: Kanker payudara *triple-negative* merupakan subtipe agresif yang menunjukkan keterbatasan respons terhadap terapi konvensional, sehingga memerlukan pengembangan strategi terapeutik alternatif. Penelitian eksperimental ini bertujuan untuk mengevaluasi potensi sitotoksik sel T sitotoksik terhadap galur sel kanker payudara MDA-MB-231 melalui sistem ko-kultur dengan variasi rasio efektor terhadap target (10:1, 20:1, dan 50:1) selama 72 jam inkubasi. **Metode:** Analisis Flowsitometri dilakukan untuk mengonfirmasi peningkatan populasi sel T $CD3^+/CD8^+$ serta ekspresi reseptor aktivasi $NKG2D^+$ setelah proses aktivasi seluler. Viabilitas sel kanker dianalisis menggunakan metode Flowsitometri, sementara induksi apoptosis dievaluasi melalui pewarnaan Annexin V–PI. Selain itu, ekspresi gen BCL-2 dan P53 dianalisis secara kuantitatif menggunakan qRT-PCR. **Hasil:** Hasil penelitian menunjukkan adanya hubungan proporsional antara peningkatan rasio efektor-target dengan penurunan viabilitas sel kanker secara progresif, di mana rasio 50:1 menghasilkan tingkat kematian sel tertinggi sebesar 77,04% dengan dominasi fase apoptosis lanjut sebesar 48,36%. Ekspresi gen anti-apoptotik BCL-2 meningkat secara signifikan pada rasio efektor tinggi ($p = 0,000$), yang mengindikasikan aktivasi mekanisme adaptif resistensi sel kanker, sedangkan ekspresi P53 tidak menunjukkan perubahan bermakna terhadap variasi perlakuan. **Kesimpulan:** Temuan ini menegaskan potensi imunoterapi berbasis sel T sitotoksik dalam menekan pertumbuhan sel kanker payudara HER2-negatif, namun optimalisasi strategi terapi masih diperlukan untuk mengatasi respons survival kompensatorik yang berpotensi membatasi efektivitas jangka panjang dalam aplikasi translasi klinis.

Kata Kunci: imunoterapi seluler, apoptosis terprogram, kanker payudara triple-negative

EVALUATION OF THE EFFECTS OF CYTOTOXIC T CELL THERAPY ON VIABILITY AND APOPTOSIS OF THE MDA-MB-231 BREAST CANCER CELL LINE IN VITRO

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ABSTRACT

Background: *Triple-negative breast cancer represents an aggressive subtype with limited responsiveness to conventional therapeutic strategies, thereby necessitating the development of alternative treatment approaches. This experimental study aimed to assess the cytotoxic efficacy of $CD8^+$ T cells against the MDA-MB-231 breast cancer cell line using an in vitro co-culture model with varying effector-to-target ratios (10:1, 20:1, and 50:1) over a 72-hour incubation period.* ***Method:*** *Flow cytometric analysis confirmed an increase in the $CD3^+/CD8^+$ T cell population and enhanced expression of the activation receptor NKG2D following cellular stimulation. Cancer cell viability was determined using the Flowsitometri, while apoptotic induction was evaluated through Annexin V–propidium iodide staining. In addition, the expression levels of apoptosis-related genes BCL-2 and P53 were quantitatively analyzed using qRT-PCR.* ***Results:*** *The results demonstrated a ratio-dependent reduction in cell viability, with the highest effector-to-target ratio (50:1) producing the greatest cytotoxic effect, resulting in 77.04% cell death predominantly via late-stage apoptosis (48.36%). A significant upregulation of the anti-apoptotic gene BCL-2 was observed at higher effector concentrations ($p = 0.000$), suggesting the activation of adaptive cellular resistance mechanisms, whereas P53 expression remained unaffected by treatment intensity.* ***Conculsion:*** *These findings indicate that cytotoxic T cell–based immunotherapy exhibits substantial potential in targeting HER2-negative breast cancer cells; however, further optimization of therapeutic parameters is required to mitigate compensatory survival responses that may compromise long-term translational efficacy.*

Keywords: *cellular immunotherapy, programmed apoptosis, triple-negative breast cancer*