Evaluating Cell Processes, Quality, and Biomarkers in Pluripotent Stem Cells Using Video Bioinformatics.

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Authors: Atena Zahedi, Vincent On, Sabrina C Lin, Brett C Bays, Esther Omaiye, Bir Bhanu, Prue Talbot

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Public Summary:
There is a foundational need for quality control tools in stem cell laboratories engaged in basic research, regenerative therapies, and toxicological studies. These tools require automated methods for evaluating cell processes and quality during in vitro passaging, expansion, maintenance, and differentiation. In this paper, an unbiased, automated high-content profiling toolkit, StemCellQC, is presented that non-invasively extracts information on cell quality and cellular processes from time-lapse phase-contrast videos. Twenty four (24) morphological and dynamic features were analyzed in healthy, unhealthy, and dying human embryonic stem cell (hESC) colonies to identify those features that were affected in each group. Multiple features differed in the healthy versus unhealthy/dying groups, and these features were linked to morphology, growth, motility, and death. Biomarkers were discovered that predicted cell processes before they were detectable by manual observation. StemCellQC distinguished healthy and unhealthy/dying hESC colonies with 96% accuracy by non-invasively measuring and tracking dynamic and morphological features over 48 hours. Changes in cellular processes can be monitored by StemCellQC and predictions can be made about the quality of pluripotent stem cell colonies. This toolkit reduced the time and resources required to track multiple pluripotent stem cell colonies and eliminated handling errors and false classifications due to human bias. StemCellQC provided both user-specified and classifier-determined analysis in cases where the affected features are not intuitive or anticipated. Video analysis algorithms allowed assessment of biological phenomena using automatic detection analysis which can aid facilities where maintaining stem cell quality and/or monitoring changes in cellular processes are essential. In the future StemCellQC can be expanded to include other features, cell types, treatments, and differentiating cells. StemCell QC has numerous potential applications in laboratories working with pluripotent stem cells or any cells that grow in colonies. We are currently using StemCellQC to evaluate pluripotent stem cell colonies grown using different culture conditions and in the presence of various drugs and chemical treatments.

Scientific Abstract:
There is a foundational need for quality control tools in stem cell laboratories engaged in basic research, regenerative therapies, and toxicological studies. These tools require automated methods for evaluating cell processes and quality during in vitro passaging, expansion, maintenance, and differentiation. In this paper, an unbiased, automated high-content profiling toolkit, StemCellQC, is presented that non-invasively extracts information on cell quality and cellular processes from time-lapse phase-contrast videos. Twenty four (24) morphological and dynamic features were analyzed in healthy, unhealthy, and dying human embryonic stem cell (hESC) colonies to identify those features that were affected in each group. Multiple features differed in the healthy versus unhealthy/dying groups, and these features were linked to growth, motility, and death. Biomarkers were discovered that predicted cell processes before they were detectable by manual observation. StemCellQC distinguished healthy and unhealthy/dying hESC colonies with 96% accuracy by non-invasively measuring and tracking dynamic and morphological features over 48 hours. Changes in cellular processes can be monitored by StemCellQC and predictions can be made about the quality of pluripotent stem cell colonies. This toolkit reduced the time and resources required to track multiple pluripotent stem cell colonies and eliminated handling errors and false classifications due to human bias. StemCellQC provided both user-specified and classifier-determined analysis in cases where the affected features are not intuitive or anticipated. Video analysis algorithms allowed assessment of biological phenomena using automatic detection analysis, which can aid facilities where maintaining stem cell quality and/or monitoring changes in cellular processes are essential. In the future StemCellQC can be expanded to include other features, cell types, treatments, and differentiating cells.

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