

ISIVF2023

P1-28

Osaka, 2023.11.2-4

A novel alarm system to detect leakage of liquid nitrogen from embryo cryopreservation container

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#### **【Introduction】**

The cryopreservation of embryos stands as a fundamental part in assisted reproductive technology. Strict maintenance of cryopreservation container is crucial. Liquid nitrogen (LN<sub>2</sub>) container consisted of vacuum layer insulated aluminum wall. At many instances, breakage of the vacuum layer causes drastic evaporation of LN<sub>2</sub> and resulting in devastating consequences. (This phenomenon is referred to as a vacuum failure.) Previously, it was demonstrated that initial frost on the container lid and subsequent condensation manifested within 15min following vacuum failure induction. Therefore, we utilized this phenomenon to invent new device to detect container accidents. In the present investigation, we deliberately induced vacuum failure in a cryopreservation container and meticulously recorded the surface temperature variations over time. Moreover, we assessed the efficacy of a monitoring system designed to identify abnormal container's surface temperature.

#### **【Method】**

A 10-liter container was completely filled with LN<sub>2</sub>, while a data logger temperature sensor, equipped with an error notification feature via e-mail, was affixed to the surface of the container. The temperature of the container's surface was continuously recorded at one-minute interval safter the vacuum failure induction and e-mail notifications were reviewed until the LN<sub>2</sub> completely evaporated. The experiment took place under room temperature condition (about 24°C). The data logger was programmed to dispatch an email notification during the surface temperature descended below 20°C, with a time interval of 3 min.

#### **【Result】**

The surface temperature started to drop 3 min after the induction of vacuum failure, and

reached below 20 °C after 6 min (19.1 °C), below 10 °C after 11 min (8.8 °C), and the lowest temperature of -0.5 °C was observed after 93 and 99 min. The temperature was 5.6 °C 400 min after the vacuum failure, when the LN<sub>2</sub> completely evaporated. The first alarm e-mail was received at 6 min after the vacuum failure induction. After that, a total of 132 alarm e-mails were received until the end of the measurement.