Transforming the Healthcare Simulation Spectrum:
Now, Next and Beyond

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Effectiveness of non-pharmacological interventions (photobiomodulation versus oral cryotherapy) on oral-mucositis among patients undergoing chemotherapy conditioning prior to haematological stem cell transplantation

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Background on oral-mucositis

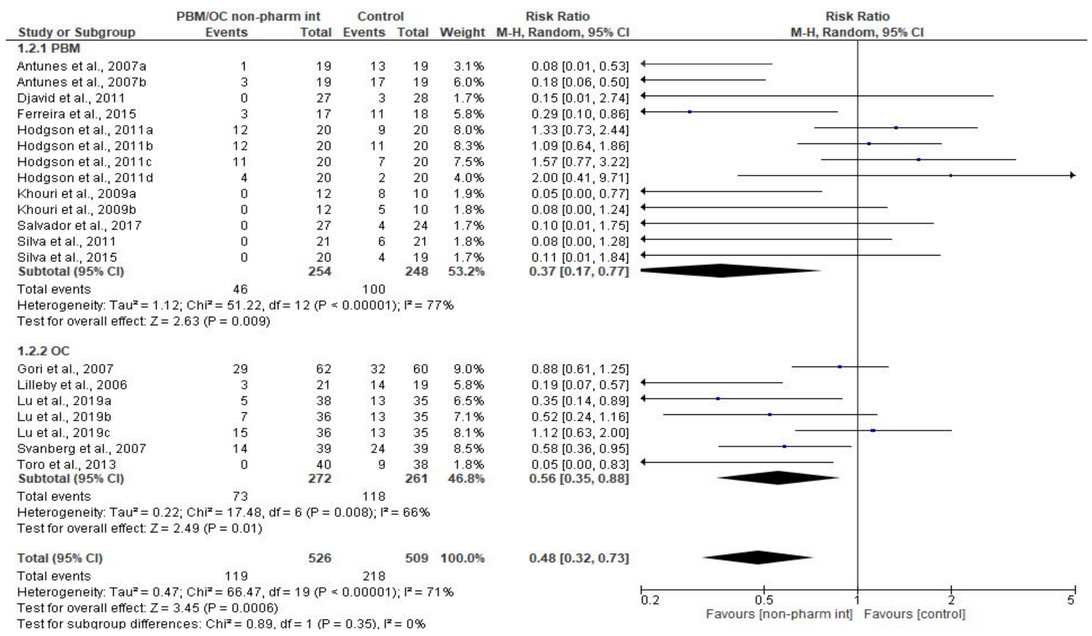
Oral-mucositis is a debilitating complication of chemo-conditioning regimens before haematopoietic stem cell transplantation (HSCT). Various health organisational guidelines recommended photobiomodulation (PBM) and oral cryotherapy (OC) as non-pharmacological oral-mucositis prevention for HSCT patients. However, current evidence is inadequate to assist clinicians in choosing the best-suited intervention for evidence-based individualized care plans.

What is Photobiomodulation (PBM)?

Chemotherapy generates reactive oxygen species (ROS), which causes oxidative stress and tissue destruction, leading to oral-mucositis [1]. Thus, interventions that protect cells from chemo-induced ROS may aid in preventing oral-mucositis. At low concentrations, ROS are useful for normal cell signalling processes. At high concentrations, ROS are highly reactive molecules that can disrupt DNA bonds, and cause cell-mediated apoptosis. ROS are created by mitochondrial metabolism and are increased when the mitochondrial membrane potential (MMP) changes. MMP may be low due to oxidative stress, excitotoxicity, or electron transport inhibition. Photobiomodulation light absorption raises MMP to normal levels, lowering ROS generation [2]. It has been demonstrated that photobiomodulation photonic energy can reduce oxidative stress in oral-mucositis development [3].

Comparing PBM vs OC

Figure 1: Effectiveness of photobiomodulation and oral cryotherapy on severe oral-mucositis incidence.



Results

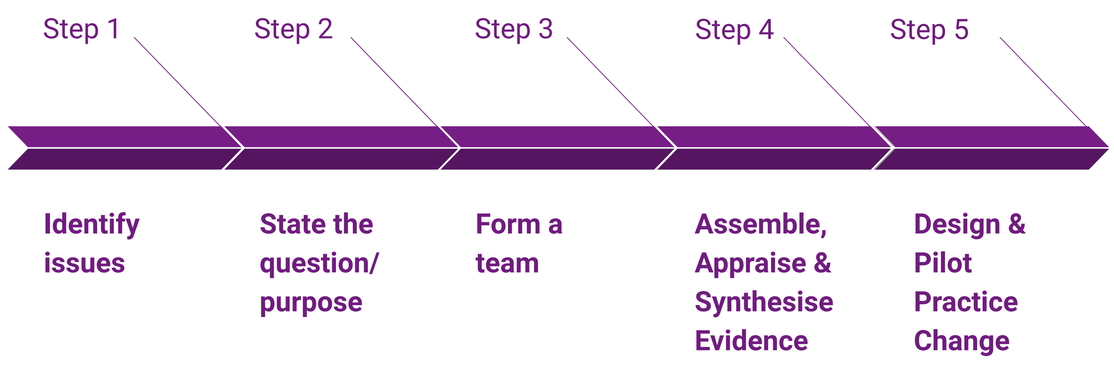
Meta-analyses included 18 RCTs (1018 HSCT patients). Both PBM and OC were effective in reducing oral-mucositis severity, severe oral-mucositis incidence, duration, and pain with small to large effect sizes. No significant differences were detected between PBM and OC across all outcomes. Subgroup analyses showed significant differences for chemo-conditioning regimens. The overall GRADE quality of evidence was low.

Application and future implications

Despite evidence showing similar effectiveness of PBM, current local practices only use OC in the management of oral-mucositis. There remained insufficient scientific evidence to determine which is superior. Therefore, future RCTs should conduct multicentre studies with large sample sizes that directly compare PBM versus OC effectiveness in preventing oral-mucositis among HSCT patients receiving chemo-conditioning. This is only possible with the application of PBM in real-life practices.

Implementation of PBM in Singapore

The PBM will be implemented in four hemato-oncological paediatric wards with evidence-based practice models to guide its execution. For PBM, the recommended parameters to reduce oral-mucositis severity and duration in HSCT patients before chemo-conditioning is 660-nm wavelength, 40mw power, 0.16J power, 1W/cm2 power density, 4J/cm2 energy density, and 0.04cm2 spot size [17]. For pain relief, the range of PBM total energy should be 15.36–20.16J [18].



Utilising simulation in training

Various methods will be used to train users.

Task Trainers
- Mouth models
- Mannequin
- Gamified model

E-learning
- Theory based
- Situational Quizzes

Virtual Reality
- Real-life simulation
- Role-play simulation

Hybrid Model
- ADPIE based
- Blended model

Conclusion

With the data collected from the execution of PBM in Singapore, future research should explore the influence of chemo-conditioning intensities, patient-related risk factors and genetic-metabolic determinants of oral-mucositis on the severity of oral-mucositis.

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