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## Cost-Effectiveness of a Nonpharmacological Intervention in Pediatric Burn Care

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### ABSTRACT

**Objective:** To report the cost-effectiveness of a tailored handheld computerized procedural preparation and distraction intervention (Ditto) used during pediatric burn wound care in comparison to standard practice. **Methods:** An economic evaluation was performed alongside a randomized controlled trial of 75 children aged 4 to 13 years who presented with a burn to the Royal Children's Hospital, Brisbane, Australia. Participants were randomized to either the Ditto intervention (n = 35) or standard practice (n = 40) to measure the effect of the intervention on days taken for burns to re-epithelialize. Direct medical, direct nonmedical, and indirect cost data during burn re-epithelialization were extracted from the randomized controlled trial data and combined with scar management cost data obtained retrospectively from medical charts. Nonparametric bootstrapping was used to estimate statistical uncertainty in cost and effect differences and cost-effectiveness ratios. **Results:** On average, the Ditto intervention reduced the time to re-epithelialize by 3 days at AU\$194 less cost for each patient compared with standard practice. The

incremental cost-effectiveness plane showed that 78% of the simulated results were within the more effective and less costly quadrant and 22% were in the more effective and more costly quadrant, suggesting a 78% probability that the Ditto intervention dominates standard practice (i.e., cost-saving). At a willingness-to-pay threshold of AU\$120, there is a 95% probability that the Ditto intervention is cost-effective (or cost-saving) against standard care. **Conclusions:** This economic evaluation showed the Ditto intervention to be highly cost-effective against standard practice at a minimal cost for the significant benefits gained, supporting the implementation of the Ditto intervention during burn wound care.

**Keywords:** burns, child, cost-effectiveness, economic evaluation, nonpharmacological intervention, randomized controlled trial, re-epithelialization.

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### Introduction

It is estimated that more than 500,000 children worldwide are hospitalized with a burn injury every year [1]. Burn care is undeniably expensive and arguably has one of the highest financial costs in pediatric health care, yet limited health economic research has been conducted in the burns arena. External financial pressures on health care budgets create much deliberation and contentious debates over balancing quality health care versus less costly service delivery [2]. There is a great need for health research to extend beyond providing evidence of one

practice being more effective than another. Changes in practice need to be quantified in monetary terms with an economic evaluation to determine the feasibility of implementing new cutting-edge treatments and interventions [3] and to justify setup costs to hospital administrators. Psychosocial costs to the patient include the pain, anxiety, and stress from the trauma of the burn injury itself and the associated wound care procedures and may encompass additional psychosocial issues resulting from the physical disfigurement of hypertrophic scarring. Severity of injury does not predict psychological costs to the patient [4]. No quality-of-life measure has been specifically developed and

**Conflict of interest:** One of the supervisors of the trial, Roy M. Kimble, holds options with Diversionary Therapy Technologies (DTT); however, he did not stand to lose or gain financially or personally from the results during the clinical trial period and the time of submission. The principal researcher has no financial interest in the Ditto device or DTT.

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1098-3015/\$36.00 – see front matter © 2015 Published by Elsevier Inc. on behalf of International Society for Pharmacoeconomics and Outcomes Research (ISPOR).

<http://dx.doi.org/10.1016/j.jval.2015.04.011>

validated for the pediatric burn population [3,5]. Financial accountability that extends beyond acute wound care and scar management and includes the complete long-term psychosocial costs to the patient makes the “true” costs of burns unquantifiable.

The most comprehensive cost-effectiveness analysis identified in the burn literature was a prospective study over a 5-year period conducted in the Burn Centre of Valencia, Spain [6]. This study incorporated incremental cost-utility ratio analysis to determine the cost and quality of life of burn patients. This cost analysis largely depended on Diagnostic Related Groups, used silver sulfadiazine in the treatment of burn wounds, and was carried out for primarily an adult inpatient population with a mean age of 40 years and mean total body surface area (TBSA) burns of 18.2%. General Diagnostic Related Group and Healthcare Resource Group cost coding provide a generic snapshot of costs and are not sensitive measures for picking up differences across individuals [7].

Two studies were identified in the burn literature that performed a cost-effectiveness evaluation on minor burns encompassing smaller TBSA (mean  $\leq 10\%$ ) and primarily partial-thickness depth [8,9]. Both studies compared burn dressings, which are not standard practice in burn centers in developed countries. Advances in the technology of burn dressings in recent years have changed standard practice from twice-daily applications of silver sulfadiazine and similar ointments or creams to improved silver-impregnated dressings such as Acticoat [10]. This change in practice has seen a shift from inpatient to outpatient management of the small partial-thickness burn injury, in which dressings are changed every 3 to 7 days. No economic evaluation has been performed in pediatric burn outpatients that uses advanced silver-impregnated dressings only, or that uses validated measures of re-epithelialization and wound depth.

This study aimed to establish the cost-effectiveness of a computerized procedural preparation and distraction intervention Ditto, which was compared with standard practice, in a randomized controlled trial (RCT) measuring burn re-epithelialization [11]. Use of virtual reality and computerized nonpharmacological interventions plays a significant role in dampening pain perception when used as an adjunct to pharmacological intervention during burn care and rehabilitation [12–21]. Several studies report on the effect of stress in delaying wound healing [22–29], and cellular links between pain and delayed wound healing are beginning to be explored [30]. The risk of hypertrophic scar formation is known to increase when wound re-epithelialization extends beyond 14 days [31,32]. Accelerating re-epithelialization is the prime objective of burn care, and has significant cost benefits to the health system and the patient.

## Methods

### Setting and Participants

Data were collected from the Stuart Pegg Paediatric Burns Centre at the Royal Children’s Hospital, Brisbane, which is a tertiary pediatric burn referral center servicing approximately 800 new patients per year. Data collection occurred in two parts: 1) RCT [11,33] data collected from August 2011 to August 2012 and 2) retrospective review of medical charts from August 2011 to September 2013 to obtain scar management data 12 months after re-epithelialization (Fig. 1). Children were included if they were aged 4 years to 13 years and had an acute burn injury of TBSA less than 15%. Children were ineligible if they were non-English speaking, had a diagnosed condition or illness in addition to a burns injury, or had a history of suspected child abuse. On the first dressing removal, further study eligibility was determined

(because of the inability to predict patient and wound management needs when wounds are covered on consent) including the following: erythema only, skin graft required, use of Entonox. The standard medical treatment received by patients was not altered by study participation. The Queensland Children’s Health Services (Royal Children’s Hospital) Human Research Ethics Committee and The University of Queensland Ethics Committee approved this RCT and it was registered with the Australian New Zealand Clinical Trials Registry (ACTRN12611000913976).

### Interventions

Administrative staff external to the study used a portable computerized random number generator to randomly assign participants to one of two groups: 1) to receive the Ditto intervention [34], consisting of a computerized multimodal device delivering the procedural preparation in the waiting room, and then the distraction intervention during wound care procedures; or 2) to receive standard preparation and standard distraction (such as videos, books, toys, television, and/or parental soothing).

### Data Collection

#### Part 1. Prospective data collection: RCT

Recruitment and consent of participants occurred at the first change of dressing, where burn wounds were scanned with the Moor LDI2-BI2 laser Doppler imager (Moor Instruments Limited, Devon, UK) to measure burn depth, enabling accurate wound comparison across participants. Additional clinical characteristics collected included the following: mode of burn, TBSA of burn, site of burn, first aid administered, and skin tone. Visitrak grids (Smith + Nephew, London, UK) were used at every dressing change to determine the percentage of wound re-epithelialization, the primary outcome measure of the RCT. Visitrak was the chosen measure of re-epithelialization for this study (over blinded reviewers determining the percentage of re-epithelialization from photos taken at every dressing change [11]) due to Visitrak’s valid and reliable wound measurement technique [35,36] using mathematical calculations rather than clinical judgment. Clinical cost data collected at every dressing change until burn re-epithelialization included the following: dressing type (primarily Acticoat or Acticoat 7, with or without Mepitel®) determined by consultant clinical judgment, and quantity of dressings applied; pharmacological pain relief administered (narcotic [oxycodone opioid, 0.1–0.2 mg/kg]; narcotic combined [oxycodone and either paracetamol or ibuprofen; or codeine and paracetamol]; or non-narcotic analgesia [paracetamol and/or ibuprofen]); and nursing and consultant time taken per patient.

Caregivers completed a general demographic questionnaire (including pertinent cost-related questions regarding transport, parking, days off work due to attending burn center appointments, employment benefits received, highest education level, employment status, family income per annum, and postcodes to establish socioeconomic status [using Socio-Economic Indexes for Areas] [37]).

### Effect Estimation

The number of days from injury until more than 95% re-epithelialization was used as a measure of the intervention effect. Minimizing the number of days to re-epithelialize reduces the likelihood of hypertrophic scarring [31,32,38] and therefore may reduce the cost to the health system and the patient.

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