OPTIMIZING PLASTER MIXTURES BASED ON CURING TEMPERATURE, MATERIAL RATIOS, AND FINANCIAL COST

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INTRODUCTION
Plaster is a common material used in the production of prosthetics and orthotics. Clinicians take a negative cast of a patient’s limb to create a positive model out of plaster for modifications and production. Traditionally, the mixture ratio of plaster to water has been subjectively determined by the practitioner. The subjective nature of this approach could result in wasted material that increases production costs. Reimbursement from Medicare and third party payers for P&O services continues to decrease, making a reduction in material costs beneficial to practice management. However, by reducing the amount of plaster and increasing the volume of water, curing temperature is expected to decrease, therefore increasing curing time, which could negatively affect production costs. The purpose of this study was to define the optimal ratio of plaster to water that maximizes curing temperature and minimizes the financial cost.

METHOD
Five mixture ratios were used, starting with the standard mixing ratio given by United States Gypsum Corporation (100 parts plaster : 70 parts water) and including ratios with more plaster (105:65 & 110:60), as well as ratios with more water (95:75 & 90:80). Five PVC pipes (3”x10”) were used to create cylindrical plaster molds. The plaster was poured and the surface temperature of each model was taken using an infrared thermometer at five-minute increments for one hour. The cost of the plaster sample was found by taking the dry weight of plaster and dividing it by the cost of the plaster per gram. Plaster was purchased at $11.90 per fifty-pound bag. Optimal mixture was calculated by first normalizing cure temperature and cost to the control mixture (100:70). Increasing cure temperature should correlate to a stronger mixture and is considered a positive outcome so the formula used was (cure temperature of ratio(n) / cure temperature of 100:70 ratio). Decreasing cost is considered a positive outcome so the formula used was (cost of sample ratio(n) / cost of 100:70 ratio). Linear interpolation lines were then drawn through these data points. The optimal plaster ratio would then be the intersection of these two lines.

RESULTS
Peak curing temperature and cost both increased with increasing the relative amount of plaster in the mixture. Peak cure temperature was 88.1°, 86.5°, 90.5°, 80.3°, and 80.9° and cost per sample were $0.57, $0.54, $0.52, $0.49, and $0.46 for 110:60, 105:65, 100:70, 95:75, and 90:80 respectively. The optimal plaster ratio was very close to the amount recommended by the United States Gypsum Corporation (100:70) (Figure 1).

DISCUSSION
These results show that as the amount of plaster increases, temperature will also increase, therefore decreasing curing time. This is beneficial for increased productivity because the positive model can be modified earlier. However, the current optimization method places an equal weighting on temperature and cost. This may not be the best assumption because the time saved by curing at a higher temperature and the strength associated with higher temperatures may result in additional cost savings due to increased productivity (decreased labor costs) and lower probability of model damage during fabrication (decreased labor and plastic costs). These indirect cost savings may exceed the additional direct costs of using more plaster and underscore the need to develop a better optimization model.

CONCLUSION
In conclusion, this data currently suggest the optimal plaster ratio is close to the manufacturer recommendation of 100:70 but more research is necessary to account for how these ratios affect strength and productivity in a P&O setting. This research is a necessary first step to improve practice management in an ever-changing reimbursement environment.

CLINICAL APPLICATIONS
Plaster is a common material used in P&O clinics and optimization of manufacturing using plaster will help reduce costs associated with providing clinical care.

REFERENCES