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Farm animal embryo technologies: Achievements and perspectives

Keith J. Betteridge *

Department of Biomedical Sciences, Ontario Veterinary College, University of Guelph, Guelph, ON, Canada N1G 2W1

Abstract

Progress and changes in embryo technology in farm animals are briefly reviewed in terms of how well embryos can be made and used and what the subject has taught us about the maintenance of pregnancy and reproduction in general. Generalizations are made about the need to not accept dogma, how initially complex techniques always become simplified and thereby more applicable, and the need for the support of long-term and basic research. Personal views are offered on how best to prepare and motivate the next generation of scientists in the field, and the need for scientists to engage in the debate of how embryo technologies should be used responsibly in countering global inequalities.

Keywords: Embryo transfer; Cattle; Sheep; Pigs; Horses

1. Introduction

Embryo technology or embryo transfer (ET) was as fashionable a term 30 years ago as it is today, but the procedures it conjures now were unimaginable then. Despite the enormous changes, however, the embryo itself, its survival of transfer, and the quality of the animal it produces still measure the success of any embryo manipulation. Therefore, progress in embryo technology can be gauged in terms of how well we reproductive biologists can make and use embryos, and how much they have taught us about the maintenance of

* Tel.: +1 519 824 4120x58258; fax: +1 519 767 1450.
E-mail address: kbetter@uoguelph.ca.

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pregnancy and reproduction in general. The extraordinary progress and diversification in what was initially a narrow field should also lead us to consider how well, or poorly, our education prepared us for coping with rapid change, and how we might improve the preparation of our successors. Thus the twin themes of progress made and lessons learned will be explored as a means of giving perspective to the work that we do. Some parts of this paper have been published in the Proceedings of the 23rd World Buiatrics Congress [1].

2. Progress made

In my opinion, the development and application of ET in cattle has been an excellent example of how professionals should interact for the good of animal production. The collegiality of veterinarians, animal scientists, and biologists in the International Embryo Transfer Society (IETS) is exemplary and has paid important dividends, notably in the elaboration of internationally accepted procedures for moving embryos around the world. The history and current status of ET have been reviewed recently [2–4], describing how it has evolved through ''three generations''—the first with embryos derived from donors (in vivo), the second with embryos produced in vitro, and the third including further in vitro techniques, notably somatic cell nucleus transfer (NT) and transgenesis.

More than half a million (584,762) bovine embryos were reported to have been transferred in 2003, 40% of them after freezing and thawing and 18% having been produced in vitro [5]. North America is still the centre of most activity (45% of the transfers) with Europe and South America each accounting for 20% of the transfers in 2003. Collection of these data is fraught with difficulties and so they are inevitably subject to error [5] but the IETS data retrieval committee, chaired by Dr. Michel Thibier, deserves great credit for assembling them and analyzing regional and technical trends. Regional differences are striking. For example, 64% of bovine embryos collected in the USA in 2003 were from beef cattle whereas 80% of donor cattle in neighbouring Canada were of dairy breeds. There is general agreement that a severe limitation to the more widespread use of ET is the problem of reliably inducing superovulation in selected donors. Transvaginal ultrasonically guided ''Ovum Pick Up'' (OPU) at frequent intervals, in combination with in vitro fertilization (IVF), is proving a more efficient route for producing embryos from individual donors where facilities and skills permit [6,7]. Embryo sexing is quite widely practised; in Canada in 2003, almost 10% of embryos transferred were sexed, close to 2000 of them after freezing and thawing [5].

Bovine ET has directly involved large animal veterinary practitioners from the beginning. However, their participation in routine field ET, which was absolutely essential when ET first became commercial in the early 1970s and collection and transfer were performed surgically, has gradually devolved, much as did their role in AI, earlier. It has been predicted that the devolvement will continue, at least in North American ET practices [3]. This is perhaps understandable, given that the challenge of putting a new technique to practical use has long since passed, but it is important to note that the need for veterinary involvement remains. Certification procedures demand it and, much more importantly, so does the proper appreciation of the potential of ET in disease control and investigation [8,9]. A particularly good example of the importance of such an appreciation is the