Basic science research in Australian intensive care practice

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ABSTRACT

Objective: A number of recent therapeutic advances have resulted from basic science research. With the change in medical education and practice towards evidence-based medicine, we wished to determine the role of basic science research in Australian intensive care practice. We believe this is the first survey of Australian intensivists and trainees to assess the influence of basic science research on their clinical duties. We discuss the importance and influence of basic science in intensive care practice and the development of postgraduate appreciation of basic science, highlight the impact of some of the changes in medical education on basic science undergraduate teaching, and discuss the clinical applicability and current participation in basic science research.

Methods: A questionnaire was mailed in November 2006 to all registered Fellows and trainees of the Joint Faculty of Intensive Care Medicine who were resident in Australia.

Results: 267 of 801 surveys were returned (33% response rate): 74% of respondents believed basic science is an important or very important influence on clinical decision-making, which is consistent with previous studies, and 8% believed it is crucial. The most familiar areas of basic science research are those with established clinical applications, such as drug metabolism, regional perfusion and the complement cascade. Most current intensive care practitioners were taught basic science as undergraduates. Involvement in basic science research increases during intensive care training, from 10% before a medical degree to over 30% at the end of training, with over a quarter of practising intensivists having a basic science degree. Despite this increase in interest during training, only 9% of journal club attendees reported that they discuss basic science articles.

Conclusion: Critical care practitioners consider basic science research to be relevant and important to their practice. There is interest in clinically applicable basic science research, but few people regularly review basic science articles at journal clubs. Reassuringly, participation in basic science research increases throughout intensive care training, despite changes in medical education and lack of protected time for research.

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In an age when training and clinical practice are geared towards evidence-based medicine, the basic sciences seem to have been de-emphasised. We question the impact this has on basic science research in Australian intensive care practice. Basic science research has improved our understanding of pathophysiological processes,[1] particularly in areas such as coagulation[2] and inflammation,[3] and has led to many recent revolutionary therapies in critical care,[4,5] such as activated protein C and recombinant factor VII. We therefore undertook a postal survey:

- to establish how important a part basic science plays in clinical decision-making;
- to gauge the awareness of recent basic science research in critical care;
- to document undergraduate and postgraduate basic science education; and
- to determine how much basic science research is being performed and in what areas.

Methods

For the purposes of this study, the basic sciences were considered to be the traditionally taught medical school biological subjects, rather than more diverse areas, such as education, biomedical engineering and psychology. The basic sciences were defined as "the study of the normal function of the human body and how it reacts to injury".

A questionnaire was constructed following a MEDLINE search of basic science research pertinent to intensive care published in the English language over the past 10 years, and categorisation of the articles into broad subject areas. The questionnaire asked about demographics, exposure to basic science during undergraduate and postgraduate training, the influence of basic science on clinical decision-making, involvement in journal clubs, and involvement in basic science and clinical research (Appendix 1). Participants were asked to rate their knowledge of this research on a three-point scale: poor, fair or good. They were also asked to rate the influence of basic science on clinical decision-making on a five-point scale: not important, mildly important, important, very important or crucial.

Questionnaires were mailed in November 2006 to Fellows and trainees of the Joint Faculty of Intensive Care Medicine who were resident in Australia.

Table 1. Demographics of respondents

	No of respondents (%)
Position	
Consultant	184 (71%)
Senior registrar	32 (12%)
Registrar	41 (16%)
Resident	1 (0.4%)
Experience (years)	
0–5	88 (34%)
6–10	50 (19%)
11–15	50 (19%)
16–20	23 (9%)
⩾ 21	47 (18%)

Table 2. Reported focus of journal clubs

Type of article	Focus of journal club
Original clinical research	95%
Meta-analyses	43%
Review articles	40%
Basic science research	9%

Results

Respondents

Eight hundred and one questionnaires were mailed, and 267 were returned (33% return rate). Nine responses were from retired consultants and included no data, so were excluded from the analysis. The response rate for consultants was 184/532 (34%) and for trainees was 74/260 (28%). The respondents had a wide range of experience and worked in units with a representative casemix (Table 1).

Journal clubs

Most respondents (70%) participated in a journal club. Most reported that the club concentrated on original clinical research articles (95%), followed by meta-analyses (43%), and review articles (40%). Only 9% of journal club attendees reported that their clubs concentrated on basic science research articles (Table 2).

Influence of basic science on clinical practice

Overall, 74% of respondents reported that basic science had an important or very important influence on their clinical decision-making (Figure 1). This was the case whether or not the respondent was participating in basic science research. Eight per cent of consultants thought that the basic sciences were a crucial influence on their decision-

Figure 1. Perceived influence of basic science on clinical decision-making among 258 Fellows and trainees in intensive care (% of respondents)

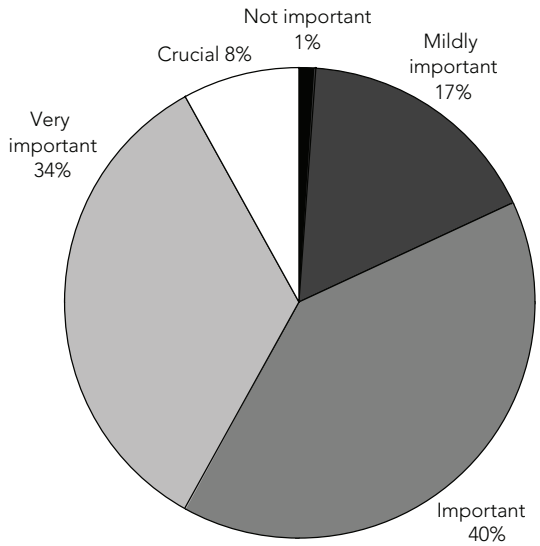


Figure 2. Areas of basic science research in Australian intensive care units

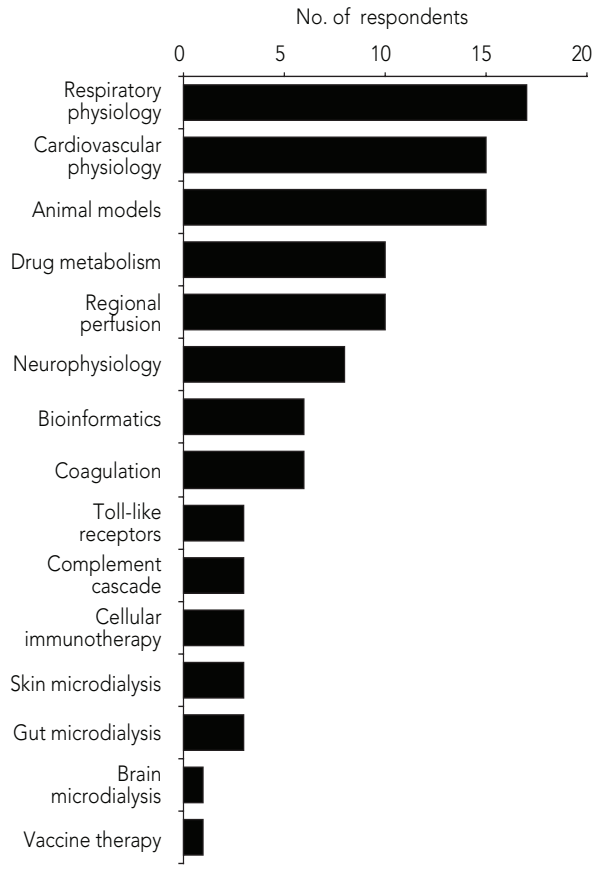
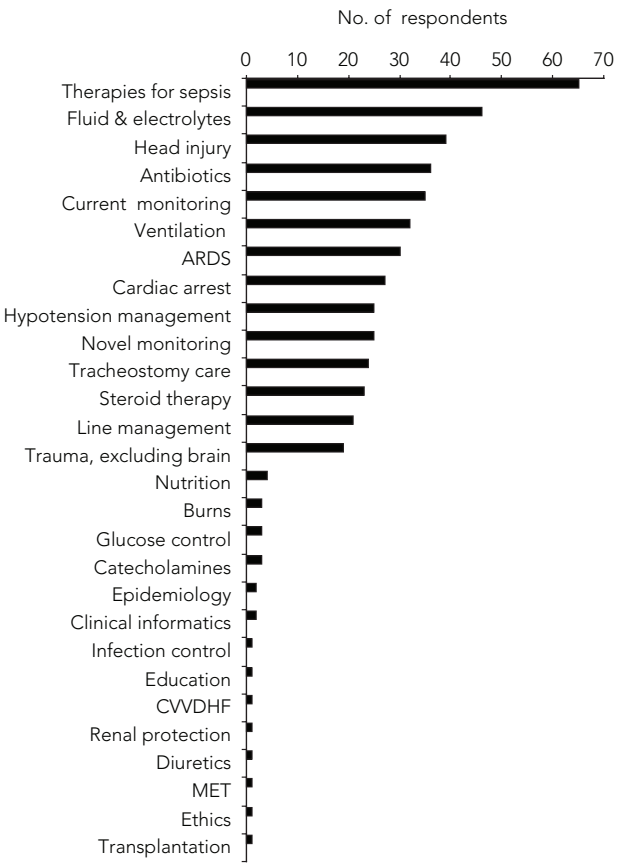


Figure 3. Areas of clinical research in Australian intensive care units



ARDS = acute respiratory distress syndrome.
MET = medical emergency teams.
CVVDHF = continuous veno–venous haemodiafiltration.

making, with 16% considering them a mildly important influence. Factors such as the experience of the doctor and unit casemix did not appear to change the influence of basic sciences on clinical decision-making.

Teaching of basic sciences at undergraduate level

Most respondents had been taught the basic sciences as separate subjects (85%), with most of the remainder having had integrated teaching, and only five respondents not having been taught basic science as an undergraduate.

Participation and knowledge of basic science research

Most respondents were involved in ongoing research: 14% reported being involved in basic science research, and 64% in clinical research. However, only 17% reported having protected time for research. In terms of basic science research, 27% of respondents had published a basic science research paper, just under 20% had submitted a grant application with a basic science question, and 26% had links to a basic science group. Thirty-seven per cent had experience in handling animals (mostly small mammals), and most were aware of the ethical guidelines for the handling of animals.

There was a threefold increase in the involvement in basic science research during intensive care training, from just under 10% involved before a medical degree to just over 30% involved during intensive care unit training. Twenty-seven per cent of respondents had a basic science degree; this degree was not in a traditional medical science in over a quarter of cases.

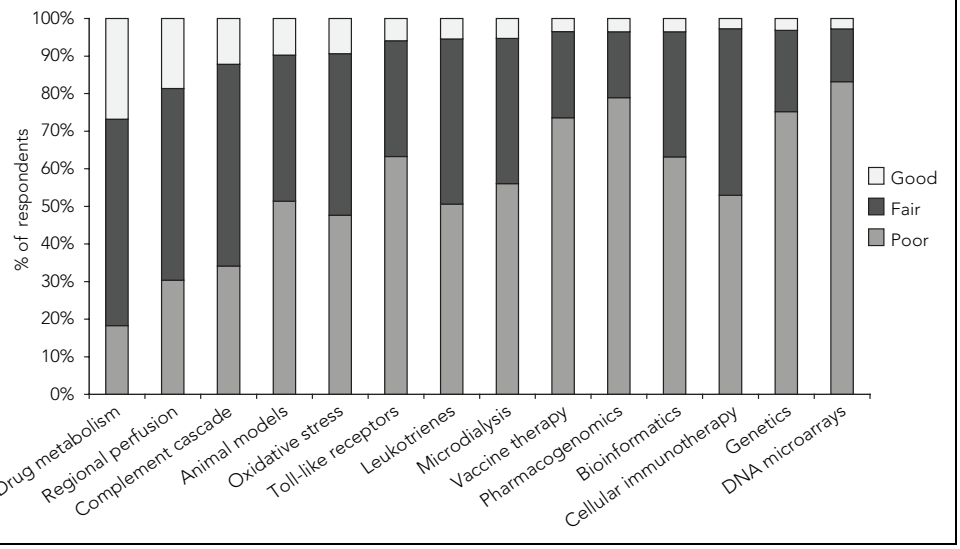
Current research had a clinical focus. Most of the Australian basic science research reported was in respiratory physiology, cardiovascular physiology and animal models, followed by drug metabolism and regional perfusion (Figure 2). Microdialysis remained an emerging technique. Clinical research focused on therapies for sepsis, fluid and electrolyte therapy, and head injury (Figure 3). There was also an interest in antibiotic therapy, current monitoring, ventilation modalities and acute respiratory distress syndrome. Less popular areas of research included hyperbaric oxygen, transplantation, ethics, education and medical emergency teams.

Self-rated knowledge of recent basic science research also concentrated on areas pertinent to clinical practice (Figure 4): drug metabolism, regional perfusion, complement cascade, animal models and oxidative stress (10%–27% of respondents rated their knowledge of research in these areas as "good"). Areas where self-rated knowledge of recent research was poorest were nutritional genomics, proteomics, cellular reprogramming and DNA microarrays (83%–92% rated their knowledge as "poor").

Discussion

The importance of the basic sciences to clinical management shown in this survey is consistent with the results of previous studies. Burnstein and colleagues surveyed anaesthetists in the United Kingdom on the relevance of the basic science syllabus to their post-fellowship clinical practice.[6] The respondents felt that 65% of the syllabus was relevant, with varying opinions about specific areas. Topics regarded as irrelevant in that study included biochemistry, endocrinology, membrane theory and immunology. Yet, despite the importance of basic science on our practice, there is acknowledgement that fewer than 10% of us read basic science articles in journal clubs. In some part, this unpopularity of basic science articles may be due to their inaccessibility. The larger circulation clinical journals have recognised the increasing importance of preclinical research,[7] and basic science articles are becoming more popular in general

Figure 4. Self-rated knowledge of recent basic science research among 258 intensive care Fellows and trainees



surgical journals.[8] Importantly, it has been shown that developing a reading strategy for basic science articles improves learning and reading in these areas.[9,10] However, despite the apparent unpopularity of basic science articles, overall basic science knowledge increases during residency, albeit at a slower rate than clinical knowledge.[11]

Basic science knowledge and appreciation has been shown to improve during training in other specialties,[12] and it is encouraging that basic science involvement increases threefold during ICU training in Australia, with over 30% involved by the end of their training, and 27% having a basic science degree. Postgraduate basic science training has been examined in the fields of surgery and anaesthesia. Anaesthetists have been shown to feel increasingly over their careers that basic sciences are relevant to their clinical practice, and to believe that they cannot effectively treat most clinical problems without a detailed knowledge of underlying biological processes.[13]

Over the past decade, medical education has moved away from traditional teaching methods towards problem-based learning (PBL) in an effort to make the curriculum more clinically relevant. With the changes in approach to medical education, has come a change in practice to become "evidence-based" and a perceived focus away from the basic sciences. However, there is evidence that basic science knowledge learned in the context of a clinical case is actually better comprehended and more easily applied by medical students than basic science knowledge learned in isolation.[14-18] A study comparing students of an old and a new curriculum in the Netherlands showed that students experienced the teaching of basic sciences as more exciting when it was integrated into organ system blocks with clinical bearings, although they were less positive about the actual importance of these sciences.[19] Rudland and Rennie showed that students thought most of their basic respiratory science objectives were relevant to clinical practice.[20] It is not uncommon for PBL graduates to think they have deficiencies in their basic science knowledge base.[21-23] However, it has been shown that perceived knowledge deficiencies and actual knowledge of anatomy do not differ at the end of undergraduate medical education between PBL and non-PBL medical schools.[24]

It is interesting and perhaps understandable that most of the appreciation of basic sciences is towards more clinically applicable areas, such as cardiorespiratory physiology and drug metabolism. When intensivists in the UK were asked to submit research questions in critical care medicine in 2000, the most frequently identified topics were the evaluation of high dependency care, ICU characteristics, treatment of acute lung injury and acute renal failure, nurse-to-patient ratios, pulmonary artery catheter, aspects of medical and nursing practice, protocol evaluation, and interhospital transfers.[25] The authors recognised that the lack of questions on treatments targeting the immuno-inflammatory cascade in sepsis may have been due to recent negative studies in these areas.[26] It will be interesting to see the impact of future basic science research and the interventions that might follow.

Finally, it is clear that, despite competing pressures, a good proportion of clinicians are still able to participate in basic science research. It has also been recognised that basic science research is difficult to conduct because of the lack of protected time[27] and lack of access to basic science facilities;[28] the importance of basic science research has been recognised by major funding agencies. The US National Institutes of Health, the world's largest biomedical research agency, spent two-thirds of its $28 billion budget in 2004 on fundamental biomedical research. It has embarked on a program, New Pathways to Discovery, to encourage closer collaboration between basic, translational and clinical scientists.[29] With over a quarter of Australian intensivists having a basic science degree, it is clear that there is a good deal of collaboration in Australian ICU research.

Conclusions

Clearly, basic sciences remain important to Australian intensive care clinical practice — improving our understanding of underlying pathophysiology, underpinning novel therapies and helping us in clinical decision-making. It is encouraging that postgraduate education in basic science and participation in basic science research remain strong despite clinical pressures and changes to medical curricula.

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Appendix 1. Survey questionnaire

Awareness of Basic Science in Intensive Care

Introduction

Following attending the 2nd Basic Science Symposium in Brisbane I have chosen to find out the awareness of Basic Science amongst Australian Intensivists and trainees.
The results will hopefully form my JFICM project.

Basic Science is the study of the normal function of the human body and how it reacts to injury. It is often artificially divided into different subjects for teaching purposes such as anatomy, physiology, pharmacology, genetics, physics and clinical measurement, biochemistry, and metabolism, however most of these areas are integrated. It can be studied at various levels from organ systems down to cellular and molecular level. An understanding of Basic Science is important in Intensive Care, it forms the basis of our interventions and research into novel therapies.

Thank you for taking the time to complete it. Please return via mail.

Survey

1. Demographics

What is your current position ?
- ☐ Consultant
- ☐ Senior Registrar
- ☐ Registrar
- ☐ Resident

If you are not a Consultant,
- are you registered with JFICM ? ☐ Yes ☐ No
- which training stream are you from ?
  - ☐ Anaesthesia
  - ☐ Physician
  - ☐ Emergency
  - ☐ Surgery

How many years experience in ICU do you have ?
- ☐ 0-5
- ☐ 6-10
- ☐ 11-15
- ☐ 16-20
- ☐ 21+

What is the majority caseload of you ICU ?
- ☐ Medical
- ☐ Surgical
- ☐ Evenly mixed

Which specialities does your ICU service ?
- ☐ Trauma
- ☐ Neurosurgery
- ☐ Cardiothoracic
- ☐ Burns
- ☐ Obstetrics
- ☐ Oncology
- Transplantation:
  - ☐ Liver
  - ☐ Heart-lung
  - ☐ Stem cell
  - ☐ Renal
- ☐ Haematology

How many ventilated beds does your ICU have ?
- ☐ 1-4
- ☐ 5-8
- ☐ 9-12
- ☐ 13-16
- ☐ 17-20
- ☐ 21-24
- ☐ 25+

How many non-ventilated beds does your ICU have ?
- ☐ 1-4
- ☐ 5-8
- ☐ 9-12
- ☐ 13-16
- ☐ 17-20
- ☐ 21-24
- ☐ 25+

How much of an influence do you think Basic Science plays in your clinical decision making ?
- ☐ Not important
- ☐ Mildly important
- ☐ Important
- ☐ Very important
- ☐ Crucial

Previous exposure to Basic Science

Were you formally taught Basic Science at University during your medical degree ?
- ☐ Yes, as separate subjects
- ☐ Yes, integrated with other subjects
- ☐ No

Have you been involved in Basic Science research prior to becoming an ICU clinician? ☐ Yes ☐ No

Do you have a Basic Science degree ?
- ☐ Anatomy
- ☐ Physiology
- ☐ Pharmacology
- ☐ Biochemistry
- ☐ Genetics
- ☐ Immunology
- ☐ Microbiology
- ☐ Other .....

Awareness of Basic Science in literature

On average, how often do you read journal articles ?
- ☐ Daily
- ☐ Weekly
- ☐ Monthly
- ☐ Yearly
- ☐ Never

Do you participate in a journal club ? ☐ Yes ☐ No

If yes, how often do you meet ?
- ☐ Weekly
- ☐ Fortnightly
- ☐ Monthly
- ☐ Intermittently

Which articles do you/ your journal club concentrate on ?
- ☐ Basic science research
- ☐ Original clinical research
- ☐ Meta-analyses
- ☐ Review articles

How would you rate your knowledge about research in the following areas?

	Poor	Fair	Good
Stem cells	☐	☐	☐
Microdialysis	☐	☐	☐
Leukotrienes	☐	☐	☐
Vaccine therapy	☐	☐	☐
Oxidative stress	☐	☐	☐
Complement cascade	☐	☐	☐
Toll-like Receptors	☐	☐	☐
Metalloproteinases	☐	☐	☐
DNA microarrays	☐	☐	☐
Cellular immunotherapy	☐	☐	☐
Cellular reprogramming	☐	☐	☐
Genetics	☐	☐	☐
Genomics	☐	☐	☐
Pharmacogenomics	☐	☐	☐
Proteonomics	☐	☐	☐
Nutritional genomics	☐	☐	☐
Bioinformatics	☐	☐	☐
Animal models	☐	☐	☐
Regional perfusion	☐	☐	☐
Drug metabolism	☐	☐	☐

Participation in Basic Science research

Have you submitted grant applications with a Basic Science question ? ☐ Yes ☐ No

Are you currently involved in research ?
- a) Basic Science ☐ Yes ☐ No
- b) Clinical ☐ Yes ☐ No

Do you get protected time for research ? ☐ Yes ☐ No

Do you or your group have links to a Basic Science Group ? ☐ Yes ☐ No

Do you have regular research meetings with Basic Science Group ? ☐ Yes ☐ No

Have you published any Basic Science research ? ☐ Yes ☐ No

Have you previously been involved in Basic Science research ?
- a) prior to medical degree ☐ Yes ☐ No
- b) during medical degree ☐ Yes ☐ No
- c) prior to ICU training ☐ Yes ☐ No
- d) during ICU training ☐ Yes ☐ No

Have you had any formal training in laboratory procedures ?
- a) by Basic Scientist ☐ Yes ☐ No
- b) by Clinician ☐ Yes ☐ No

Do you have experience in handling laboratory animals ? ☐ Yes ☐ No

If yes, which ones:
- ☐ Mice
- ☐ Rodents
- ☐ Rabbits
- ☐ Pigs
- ☐ Dogs
- ☐ Sheep
- ☐ Primates
- ☐ Others .....

Are you aware of local and national guidelines regarding laboratory research ? ☐ Yes ☐ No

Which areas of research are you involved in ?

Basic Science:
- Genetics
  - ☐ Knock-out genes
  - ☐ Susceptibility
  - ☐ Genomics
  - ☐ Pharmacogenomics
  - ☐ Oxidative stress
  - ☐ Proteonomics
  - ☐ Nutritional genomics
  - ☐ DNA microarrays
- Stem cells:
  - ☐ Cloning
  - ☐ Transplantation
- Immunology:
  - ☐ Leukotrienes
  - ☐ Toll-like Receptors
  - ☐ Complement cascade
  - ☐ Vaccine therapy
  - ☐ Cellular immunotherapy
- Microdialysis:
  - ☐ Skin
  - ☐ Gut
  - ☐ Brain
- ☐ Metalloproteinases
- ☐ Cellular reprogramming
- ☐ Animal models
- ☐ Bioinformatics
- ☐ Respiratory physiology
- ☐ Neurophysiology
- ☐ Cardiovascular physiology
- ☐ Regional perfusion
- ☐ Coagulation
- ☐ Drug metabolism

Clinical Research:
- ☐ Fluid and electrolyte therapies
- ☐ Existing monitoring
- ☐ Novel monitoring
- ☐ Tracheostomy care
- ☐ Line management
- ☐ Antibiotic therapy
- ☐ Cardiac arrest management
- ☐ Steroid therapy
- ☐ Therapy for hypotension
- ☐ Management of burns
- ☐ Trauma, excluding brain
- ☐ Head injury
- ☐ Ventilation modalities
- ☐ ARDS
- ☐ Therapies for sepsis